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ARCHEOLOGY.—*Site patterns in the eastern part of Olmec territory.* PHILIP DRUCKER and EDUARDO CONTRERAS.

During the spring of 1953, from February to the middle of May, the writers carried out an archeological reconnaissance of the eastern and southern borders of Olmec territory, in the states of Tabasco and Veracruz, Mexico. The study was made possible by a grant from the Wenner-Gren Foundation for Anthropological Research, through which field expenses were provided, and through the cooperation of the Bureau of American Ethnology, Smithsonian Institution, which made the senior author available for the work and provided various items of equipment. In addition, the courteous cooperation of the Instituto Nacional de Antropología e Historia, of Mexico, whose officers granted the necessary work permit and gave letters of introduction to civil and military authorities in the region investigated, is gratefully acknowledged.

The purpose of the work was to attempt to define the extension, on the east and south, of the territory occupied by the archeological culture known as "Olmec." It was essentially a continuation of the archeological program begun a number of years ago by Stirling, in much of which the senior author participated.[1] In the course of that work, during which several major sites were thoroughly tested, a previously unknown Mesoamerican culture was identified, its internal history and relative chronological placing was determined through analysis of its ceramic sequences, and its highly distinctive art style was defined. Nonetheless, the actual geographical extent of the culture had not been determined, except that in its developed phases, at least, it appears not to have extended north of the Papaloapan.[2] The question of territorial extent of the culture during its several periods was brought into relief by recent recognition of obvious Olmec stylistic influence in carved monuments in other parts of Mesoamerica, notably at San Isidro Piedra Parada, Guatemala, and in the Mexican highland, in Morelos and the ceramic and figurine patterns of Tlatilco.[3] If the Olmec patterns, as identified at sites tested in the southern Veracruz-western Tabasco region, could be shown to have extended back from the coast into the adjoining highlands, the distant apparent manifestations of the culture could be more easily accounted for. The problem thus bears on the larger one of the inter-relations of the several Mesoamerican culture centers or *foci*, and the means by which they influenced each other at various periods of their development to bring into being the overall high civilization of the area. In short, the survey here reported on was undertaken in an attempt to contribute to the understanding of basic areal problems.

The survey was designed to cover as much territory as possible in the course of the field season. On the basis of past knowledge

[1] STIRLING, M. W. *Stone monuments of southern Mexico.* Bur. Amer. Ethnol. Bull. 138. 1943; *Stone monuments of the Río Chiquito, Veracruz, Mexico.* Bur. Amer. Ethnol. Bull. 157, Anthrop. Pap. 43 (in press).

DRUCKER, PHILIP, *Ceramic sequences at Tres Zapotes, Veracruz, Mexico.* Bur. Amer. Ethnol. Bull. 140, 1943; *La Venta, Tabasco: A study of Olmec ceramics and art.* Bur. Amer. Ethnol. Bull. 153. 1952.

[2] DRUCKER, PHILIP. *Ceramic stratigraphy at Cerro de las Mesas, Veracruz, Mexico.* Bur. Amer. Ethnol. Bull. 141. 1943.

[3] THOMPSON, J. E. S. *Some sculptures from southeastern Quetzaltenango, Guatemala.* Carnegie Institution, Notes on Mid-American Archaeol. and Ethnol. **1**: (17), 1943; PORTER, MURIEL N., *Tlatilco and the pre-Classic cultures of the New World.* Viking Fund Publ. in Anthropology No. 19. 1953.

of the region and its routes of communication, it was decided that the most efficient means of transport would be use of saddle and pack animals, utilizing watercraft occasionally. Sites found would be test-pitted sufficiently to obtain small ceramic samples, on the basis of which they might be classified as to cultural affiliation, and, where there were features such as complexes of mounds that seemed to have significance, they were to be sketch-mapped. The locations of sites found were to be pinpointed by celestial observations, since available maps of the region show little topographic detail and are often inaccurate.

The field party consisted of Drucker and Contreras, with two Tabascan arrieros and laborers, plus various local guides and laborers. In the course of just over 100 days in the field, the party traveled an estimated 1200 kilometers of trail and river, located 80 archeological sites, and collected approximately half a ton of ceramic samples. The pottery collections were crated and shipped in small increments as frequently as the occasion offered, to the Museo Nacional de Mexico, to relieve the burden on the pack animals. Special thanks are due the director of the museum, Dr. Eusebio Dávalos H., for his kindness in receiving these small-lot shipments and having them stored pending our return to Mexico. Contreras took charge of the mapping part of the project, as well as a good share of the test-pitting; his sketches will be presented in the final report on the work. The least successful part of the project was that referring to determining site locations by celestial observations. Probably because of the mode of transport, the two watch-chronometers carried refused to settle down to uniform rates during the trip, thus adding a variable error factor to the observations.

The procedure followed was to establish temporary quarters, usually at some ranch or in some village, where pasturage could be obtained for the livestock and the party's gear left in someone's custody, and then visit the sites in the vicinity in the course of the next couple of days. Often, to save time, we split our small force, Drucker examining some sites and Contreras the others. One of the chief reasons for making our bases at modern villages and ranches was the constant need for local information. It is probable that archeologists who have not worked in this type of terrain do not appreciate how dependent one must be on local guides, to find sites. A great part of the area surveyed is covered with heavy vegetation, either virgin jungle or second growth bush. One could easily ride within a few meters of a second La Venta, or a second Uaxactun, for that matter, and never know it was there. We did find a few sites that were situated in cleared pasture lands, or that lay squarely across the trail, but we were taken to most of the archeological zones by local people. We found this information to be for the most part accurate and freely given. Only in a few instances did people, apparently suspicious of our motives, refuse to tell us of sites or to show them to us.

The track of the party is shown on the accompanying map. We set out from Huimanguillo, Tabasco, heading westward out of the Grijalva basin, then proceeding downstream along the Río Zanapa, with the general plan of circling to the northward of the Laguna Rosario. At one point we doubled back to visit some localities on tributaries of the Zanapa, then crossed into the watershed of the Río San Felipe, which we followed to the Laguna del Carmen, on the Gulf coast. Retracing our course, we returned to the Zanapa, then turned southward, west of the Laguna Rosario, to the town of San Francisco Rueda, on the railroad. From this point we crossed overland to the Río Pedregal, and proceeded upstream into the mountains. On our return from this jaunt, we crossed overland to San José del Carmen, on the Río Tancochapan (which farther downstream becomes the Río Tonalá), then traveled up the Río de las Playas to the foothill country. We also made a couple of short trips by launch downstream from San José. Next, we crossed overland to the Río Uzpanapa, followed that river up to the edge of the foothills, then back down to the village of Chichigapan. Leaving the Uzpanapa, we crossed overland to the Coatzacoalcos drainage. We traveled upstream to the tributary Rio Jaltepec and the railroad town of Jesús Carranza, then back downstream, terminating the trip at Minatitlán.

EASTERN PORTION OF OLMEC TERRITORY
SHOWING TRACK OF 1953 SURVEY
RIO GRIJALVA
TECOMINOCAN
HUIMANGUILLO
CARMEN MACHONA
LAGUNA DEL CARMEN
SAN FELIPE RIO NUEVO
SAN MIGUEL
RIO PEDREGAL
RIO DE LAS PLAYAS
HUEDA
LAS CHOAPAS
LA VENTA
TONALA
TONALA
AGUA DULCE
SAN JOSE DEL CARMEN
FRANCITO
PUERTO MEXICO
NANCHITAL
RIO COATZACOALCOS
CHICOZAPAN
SAN CRISTOBAL
HIDALGOTITLAN
MINATITLAN
ACAYUCAN
TENOCHTITLAN
JESUS CARRANZA
RIO JALTEPEC
LAGO DE CATEMACO
MILES
TRACK
18°30'
18°N
17°30'
95°W
94°30'
94°W

FIG. 1

While this coverage seems fairly extensive—and in the course of the trip it seemed a long, long road at times—it must be recognized that the coverage is by no means complete. For one thing, we did not cover the coastal area and the lower reaches of the rivers between the Laguna del Carmen and the Coatzacoalcos. Much of this region is, and was, uninhabitable swamp, but there are undoubtedly elevated areas on which archeological sites occur. Nor did we investigate the low but rugged hilly region between Las Choapas and Nanchital, although we had some reports of sites there. These two stretches were left out of the itinerary as we came to realize that the allotted time would not permit us to traverse them and the area to the south as well. Consequently, since our problem related to searching for the boundaries of the Olmec area, and not just finding sites in what was probably the heartland of the culture pattern, we deliberately bypassed these sections to concentrate on what seemed to be the border region. Another sector that was slighted is that lying between the middle courses of the Uzpanapa and the Coatzacoalcos. There are probably a good many sites in the section, but because of the sparse population and few trails, it is difficult of access. It seemed advisable, owing to the lateness of the season, to by-pass this region and to concentrate, instead, on the middle course of the Coatzacoalcos. In effect, we by no means pretend to have located all the sites in the region covered. We do believe, however, that we secured a good sampling of sites, especially in the zones critical to our problem. The region west and northwest of the Coatzacoalcos, including the San Juan and Tesechoacan drainages, according to the original plan was left for another season.

A brief sketch of the regional geography must be given, since there are so few data published on it. Most of the coastline in this part of Mexico consists of sandy beaches behind which lies a belt of high dunes, although this dune belt may be quite narrow, as for example at the Laguna del Carmen. Neither beaches nor dune belt offer much inducement to human habitation, the former because of the pounding they get by heavy seas during the "nortes" or northerly storms, the latter because of soil poverty and scarcity of water (although in recent years there has been considerable increase in settlement in the dunes, connected with coconut plantations). South of the dune belt lie the swamps, bordered by dense growths of mangrove along the watercourses. Here and there elevated areas occur, islandlike, amid the swamps, and such places are commonly occupied today, and were also used for human habitation in the past. Intermediate between the swamps and dryland areas are the locally termed "acaguales." These are tracts that flood during the wet season, and dry out, or partly dry out, during the dry half of the year. The natural vegetation is a dense tangle of scrub and vines, a prominent member of which is a small palm armed with quantities of vicious spines, mixed with large trees. These acaguales, when cleared, become the "potreros" or dry season pastures (in this part of Mexico, at least, the term potrero invariably refers to pastures that flood part of the wet season), but probably had little utility except as hunting areas prior to the introduction of animal husbandry in the area. As one proceeds inland, and to the westward as well, elevated hilly lands become both more frequent and larger. La Venta, of course, is situated on such a structure; there is a larger and quite broken area farther down the Tonalá where the oil town of Agua Dulce is, and the entire stretch transected by the road from Las Choapas to Nanchital consists of low but quite rough hills. In other places the swamps extend inland much farther. From the railroad between Rueda and San José del Carmen one can see an immense stretch of swamp to the northward, interrupted only by the mangrove galleries along the Zanapa and the Blasillo rivers. Beginning a short distance west of Huimanguillo, between the Zanapa and the Pedregal, is a strip of arid plains, locally termed "sabanas." These are characterized by a thin layer of dark gray surface soil, apparently containing a large proportion of very fine sand, overlying clays with great amounts of gravel and sand mixed into them. Apparently this soil profile is so porous that the soils have extremely poor

water-holding capacity, and are totally unsuitable for agriculture, either modern or ancient. The terrain is gently rolling, with numerous streamlets bordered by narrow gallery-forests. These savannahs are now used for grazing for the weeks or months that the potreros are flooded but they will not even support good pasture grasses; cattle lose considerable flesh during the few weeks they are kept there.

This discussion of soils and agricultural qualities of the savannahs is stressed, because we believe that this strip formed a barrier to Olmec expansion southward in this part of the region. We could find no trace of archeologic remains in the plains, with the exception of two small sites (one visited, and one only reported) on the northern shores of the Laguna Rosario.

South of the savannahs are a series of hills and ridges, and then a low-lying belt of acaguales (and now mostly potreros) that extends to the rather abrupt edge of the foothills.

South of San José del Carmen, between the Rio de las Playas and the Rio Uzpanapa, there is a strip of savannah that merges into hilly country as one proceeds inland. This is a somewhat peculiar section for it is for the most part very poorly watered, and consequently, seems to have been sparsely inhabited in the past, and has only few inhabitants today. It may be that the two rivers and their tributaries, like the Arroyo Mancuernillas which is said to head far back in the mountains, cut off the drainage from the mountains. The area between the Uzpanapa and the Coatzacoalcos, at least as much as we saw of it, is quite rugged, but has more year-around brooks and streams.

Along the major stream courses, above the edge of the swamp lands, there are extensive stretches of potreros, interrupted at intervals by ridge systems that parallel the course of the river. Many of these suggest remnants of older eroded structures; many have, in places, but shallow soil with frequent outcrops of sandstones and limestone. Others consist of coarse gravels, and perhaps are old gravel-bars. Modern settlements are almost invariably situated on and along such ridges where they occur close to the river bank, the rivers providing the chief communication routes of the region. It is only the newer villages established along rail lines and the new highways that are to be found any distance from the rivers.

In the course of the survey, 80 sites were located, and of these, 71 were tested. Ceramic samples were not collected at all the 71 sites tested, however, for at some of them no sherds could be found. At others, sherds were quite scarce; at still other sites they were abundant. This varying frequency of sherds raises a number of questions as to occupation patterns and/or duration of occupation which will be discussed in subsequent paragraphs. Wherever possible, the samples were taken from what appeared to be normal depositional areas, between and around the mounds. Testpits were dug in mounds only as a last resort, when occupational zones could not be found. The point to avoiding mound samples where possible was of course that one can never be sure just how much of the ceramics included in the mound-fill was contemporaneous with the construction, and how much of it came originally from earlier occupational deposits scraped up to get aggregate for the mound.

At the present writing, the pottery samples are somewhere en route from Mexico to Washington. Until they have been analyzed, nothing can be said as to cultural and temporal affiliations of the sites. However, there were certain variations in site patterns which were revealed by the survey that have interesting implications. These will be described and discussed briefly.

Previous investigations of Olmec sites have made clear that the major centers are characterized by earth mounds, including both conical (originally pyramidal?) and long forms, some of which are scattered about apparently irregularly, but some, and usually the larger structures, are arranged according to some obviously preconceived plan. Frequently, sets of long and conical mounds form quadrangular enclosures, or "plazas." At La Venta the arrangement is not quite so obvious, but nonetheless exists: the major features, mounds and stone monuments, are oriented along a single line, which is just a few degrees off true north. The sites Stirling has called "Rio Chiquito," and "San Lorenzo," near Tenochtitlan,

Veracruz, have several large quadrangular "plazas" and so do several subsidiary sites in the vicinity of Tres Zapotes. Presumably, such arrangements had some ceremonial significance or function.

Other sites occur in which earth mounds of various sizes were built in no obvious relationship to each other, that is, they appear to be arranged without any plan. Whether this interpretation as to lack of planning is correct, or whether the structures were spaced according to some abstruse scheme, these sites certainly present an appearance quite different from those of the preceding class.

Mention should be made of the small mounds usually found in the vicinity of the larger structures. These are usually roughly elliptical in plan (perhaps they were more or less quadrangular originally), 10 to 14 m long by 5 to 8 m wide, and from 0.3 m to about 1 m high. Such structures have not been observed to occur in obviously planned arrangements, but are scattered about irregularly, often to one side of, or surrounding, the larger structures. While we cannot offer definite proof, we are of the opinion that these small structures were platforms for dwellings. Many of them are built on today, because of the excellent drainage they provide. We found no sizeable aggregation of these small mounds that did not have one or more larger (ceremonial) mounds associated with it, although the opposite occurs in a few instances: several sites consist of a single conical mound of moderate size with no "house mounds" anywhere about.

Borrow pits are frequently associated with mound groups, particularly in certain parts of our region. These are irregular in shape, and probably were originally rather deep since they have not been filled in by accumulation of vegetal matter and aggradation during the rains.

A third type of site, distinct from the preceding ones, is that which we characterized as a defensive position. This interpretation has not been proved, but is strongly suggested by the nature of these sites: they are usually small, and situated on the very top of some steep little knoll or ridge. The structures consist principally of low long mounds, from just under a meter to about two meters in height, arranged in a rectangle that encloses the flattish top of the hill or ridge. In at least one instance, several flanking mounds had been built on what appeared to have been small prepared terraces some few meters down the slopes. Another distinctive feature of these sites is that the few that we examined were situated at some distance from a river or navigable arroyo. In fact, in no case was there even a non-drying brook, that could have provided water for domestic purposes throughout the dry season, very near at hand. It is conceivable that these may have been seasonally occupied (during the rainy season, of course). Once again we can bring no direct proof, but it seems reasonable enough that a group or groups pushing into a frontier region might begin by establishing seasonally used outposts away from routes of water-communication, in easily defensible positions.

A fourth variety of site encountered was the occupation area, as marked by more or less extensive distributions of sherds on and in the top layers of the soil, with no mounds or other structures. Such deposits occurred consistently in hilly areas, along the slopes and less commonly on top of ridges.

Only one example was found of the fifth type of site, but at least one other is known to occur in the region. This is a non-Olmec pattern, with rectangular house platforms of dry masonry, complexes of earth mounds faced with stone, usually river cobbles, and features that appear to have been ball-courts. In our opinion, these traits indicate affiliation to the cultures of the Chiapas highland, and represent intrusions toward the coastal lowland. The site on the Río de las Playas that Stirling named "La Ceiba" is of this type, according to information and notes that he made available to us, and so is Pueblo Viejo del Pedregal, which we examined.

There are strong suggestions of regional patterning in the distributions of these types. Almost all the sites located along the Rio Zanapa, and along the traverse made to the Laguna del Carmen, in other words, along the eastern border of our region, were of one or the other of the first two types

described, that is, of earth mounds including obviously planned complexes, or of mounds in no observable relationship. Sites of these two types were found elsewhere, but along with other types. A distinctive feature noted in some of the sites with planned complexes, both on the Zanapa and elsewhere in the region, not heretofore observed, is that the long mounds forming a quadrangle are sometimes joined, so that the effect is that of a continuous mound forming two or three sides of the enclosure.

Sites with no mounds whatsoever were most common along the Uzpanapa. In four instances a few house mounds were associated with such localities, but the majority of the Uzpanapa sites had no structures of any kind. A few moundless occupational areas were found in the Coatzocoalcos drainage, but were outnumbered there by sites with earth mounds.

The few sites classed as "defensive" were limited to the foothill country of the Pedregal, the Playas, and one locality between the last-named river and the Uzpanapa. If they really were frontier outposts, their locations fit well with known distribution of highland Chiapanecan centers up the Pedregal and the Playas.

Little more can be added to what has already been said about the supposedly highland sites, except to point out that both those presently known (there may be more, for example, up the Uzpanapa and its tributaries), are major centers in every sense: they are quite extensive, and include numerous complexes of structures.

Such diversity of pattern suggests at first glance cultural or temporal differences, or both. However, field inspection of the ceramic samples gave the impression that the majority of the mound sites, with and without obviously planned complexes, and many of the moundless localities, will probably turn out to belong to the Middle Tres Zapotes (or La Venta) horizon. (There appear to be one or more new, hitherto undefined, ceramic complexes at certain of the sites found, also.) If this field impression proves to be correct, it hints that the Olmec must have had, at that time, an extremely complicated ceremonial system, with hierarchies of ceremonial centers serving and being supported by subsidiary communities. At least, it seems reasonable to assume that there was some correlation between size and numbers of ceremonial mounds and the importance of the site.

The sites that lacked ceramic remains present another problem. We encountered most of these localities along the Zanapa. No sherds could be found despite intensive search for them in adjacent land, where occupational debris might have been expected, nor in either the ceremonial nor the house mounds. Absence of sherds in the mounds may have been due in part to heavy reliance on borrow pits as sources of aggregate; borrow pits are fairly common in this part of the region. However, we believe it highly possible that the builders of these structures may have been the first pottery-making occupants of the region. It is essential to add that we do *not* believe that these sites are particularly early; they probably belong to the same La Venta time horizon as neighboring sites from which we collected ceramics. The lack of occupational debris suggests a short period of habitation. Perhaps the people moved to the neighboring localities which for some reason proved to be more suitable for occupancy. To extend our hypothesis a bit further, the foregoing may mean that this Zanapa drainage was a no-man's land into which the Olmec expanded at one phase of their history. How long they utilized it cannot be determined until the collections have been studied. The fact that all the ceremonial sites (to differentiate them from the clusters of house mounds) are small, and the ceremonial mounds themselves tend to be small, seems to indicate that the maximum occupation may have been relatively short.

To summarize, it appears that Olmec culture, through most of its history, was confined to a somewhat smaller region than had been anticipated. Apparently it expanded as far eastward as the middle course of the Rio Zanapa only for a brief period. The savannahs inhibited expansion inland, up the Zanapa and up the Pedregal, and as far westward as the Rio de las Playas. Our present impression, still to be confirmed or disproved by study of the sherd samples, is that at the time of its maximum extent the

culture pushed only relatively short distances up the Playas, the Uzpanapa, and the Coatzacoalcos. Whatever the importance of its influences on other Mesoamerican patterns, the Olmec civilization seems to have been restricted to a relatively narrow strip of coast from about the Laguna del Carmen across the swampy lowlands and the rugged Tuxtla mountains to the mouth of the Papaloapan.

BIOCHEMISTRY.—*Investigations concerning the hatching factor of the golden nematode of potatoes*, Heterodera rostochiensis *Wollenweber*.[1] LOUIS M. MASSEY, JR.,[2] and A. LESLIE NEAL, Department of Biochemistry and Nutrition, Cornell University. (Communicated by G. Steiner.)

The golden nematode of potatoes or potato eelworm (*Heterodera rostochiensis* Wollenweber) is a plant-parasitic nematode which is responsible for the condition of soil known as "potato sickness." The nematode attacks the roots of the plant causing stunting and a reduction of yield which may be as great as 70 percent. It ranks among the most difficult pests to control. As yet, there is no known method of eradicating this organism once it has become established in a soil.

The life history of the golden nematode is described in Filipjev and Schuurmans Stekhoven, 1941. In brief, subsequent to the organism's invasion of and growth within the roots, the female body is transformed into a small round cyst which may contain from about 10 to 400 eggs. The cysts remain in the soil in a dormant state until exposed to an unidentified substance excreted by the potato root, which serves to stimulate hatching.

The first investigator to study the nature of the stimulant was Triffitt (1930) who found it to be non-volatile and moderately heat resistant. Hurst, as reported by Calam, Raistrick and Todd (1949), prepared a concentrate of the factor from potato soil leachings by evaporation and ethanol extraction procedures and with it was able to induce nematode hatching at a dilution of 1/500,000. Hurst concluded that the factor was an amino acid. Todd and coworkers in a series of publications (Calam, Raistrick, and Todd, 1949; Calam, Todd & Waring, 1949; Marrian, Russell, Todd, and Waring, 1949; Russell, Todd, and Waring, 1949a, 1949b; Marrian, Russell, and Todd, 1949) report attempts to isolate the active material and to synthesize active compounds. These workers concluded that the factor "is an acid probably containing a lactone group" and ascribed the name eclepic acid to this substance. The "high acidity and probable lactonic nature" led them to determine the activity of a number of tetronic acids and related compounds. Among those tested, anhydrotetronic acid was found to possess slight activity.

Investigations dealing with the hatching factor have been undertaken in this laboratory for the purpose of concentrating and identifying the active substance.

EXPERIMENTAL

Collection of leachings.—Tomatoes have been shown to excrete a golden nematode hatching factor which appears to be similar to that excreted by the potato plant (Russell, Todd, and Waring, 1949a). Since it was more convenient to use the former plant our studies have dealt with concentrating the factor from tomato leachings. The collection of relatively small volumes of leaching was accomplished by placing quart size "Sealright" cardboard containers under four-inch pots in which tomato plants were growing and allowing the leachings to drip directly into the containers. The contents of each container were frozen as soon as possible after collection. Frozen leachings have been found to retain their activity after storage periods of at least one year.

[1] Supported in part by grants from the New York State Agriculture and Market Golden Nematode Control Funds (Department of Plant Pathology, Cornell University). A preliminary report was presented at the meeting of the American Society of Biological Chemists at Cleveland, April 1951 (Federation Proc. **10**: 222. 1951). The authors wish to express their appreciation to W. F. Mai and B. F. Lownsbery, Jr., for the cyst material and for their many helpful suggestions.

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Assay method.—A comparison of the number of larvae hatched when cysts are immersed in solutions containing varying concentrations of the factor has served as a basis for estimating the relative concentration of the active substance (Fenwick, 1949, 1951a, 1951b, 1952; Lownsbery, 1951). The method used in this study is a slight modification of that developed by Lownsbery (1951) for testing the viability of larvae contained in nematode cysts.

A crude preparation of cyst material was obtained from heavily infested soil by flotation methods. The product was then air dried at room temperature and stored in a 50 percent relative humidity atmosphere. This crude preparation contained in addition to chaff, seeds, etc., approximately 7,000 cysts per g.

Aqueous extracts of this crude cyst material possessed slight hatching activity which appeared to be associated with the chaff constituent. Therefore, the chaff was removed by rolling the crude cyst material down a glass tube of 3 cm inside diameter and approximately 1 m in length. The tube which was fitted with a glass baffle about 10 cm from one end was inclined approximately 10° from horizontal, baffle end uppermost. Approximately 1 g of the crude cyst material was introduced into the upper end of the tube and the cysts and other spherical objects rolled out of the chaff by slowly rotating the tube around its longitudinal axis. The resulting material contained approximately 15,000 cysts per g and was found to be free from chaff.

Twenty mg of the chaff-free cyst material containing approximately 250 cysts were placed in a petri dish, and 20 ml of the solution to be assayed were then added. After an incubation period of 14 days at 21°C., the number of cysts present and the larvae which hatched were counted with the aid of a low power microscope. Since the number of cysts per dish is variable and a few larvae hatch from cysts placed in water, a distilled water blank as well as a solution of the initial leachings were incorporated in each assay for comparison purposes. A single source of cysts was used for an individual assay. The results are expressed as the number of larvae hatched per 100 cysts.

Concentration of the hatching factor.—Leachings were lyophilized at approximately 70 microns pressure and the residue extracted five times with 400 ml portions of absolute ethanol each time. The combined ethanolic extracts were then concentrated to 25 ml under 25 mm pressure. A white crystalline precipitate which formed during the concentration was removed by filtration and found to possess no activity. Upon the addition of 5 volumes of peroxide-free diethyl ether to the ethanolic filtrate additional inactive impurities were precipitated. After removal of the precipitate, evaporation of the ethanol-ether solution to dryness under 25 mm pressure left a residue which was not completely soluble in water. Extraction of this residue with 10 ml of distilled water and subsequent lyophilization of the aqueous solution yielded a yellow amorphous substance which is referred to as "concentrate-A."

Paper chromatography.—A study of the distribution of the hatching factor on paper chromatograms was made. Five μl of a solution (192 μg of solids per μl) of concentrate-A was applied to each of several strips of Whatman No. 1 paper (1½ x 25 inches). The strips were developed at 25°C. immediately after the spots had dried. Both ascending and descending developments were tried using 80 percent aqueous phenol, 50 percent phenol in 10 percent aqueous ethanol, and n-butanol saturated with water. After development, the strips were dried at room temperature in forced air for a 24-hour period. Beginning at one-quarter inch below the point of application for ascending developments, or one-quarter inch above the point of application for descending developments, the strips were cut into 1 inch segments and numbered consecutively. Each segment was eluted with 40 ml of distilled water which was subsequently divided into two equal portions for duplicate assays.

For comparison purposes, a "crude concentrate" of the hatching factor was prepared according to the method of Calam, Raistrick, and Todd (1949). Two μl of a solution of this product containing 180 μg of solids was subjected to paper chromatography using 80 percent aqueous phenol as the solvent. The distribution of activity on paper chromatograms of a mixture of the concentrates obtained by the two above procedures was also determined.

Leaf and root tissue preparations.—One hundred leaf punches (1 cm diam.) taken at random from ten six-week old tomato plants were floated upon 250 ml of distilled water in suitable containers and illuminated for periods of one and two days. At the end of each of these periods 20 ml aliquots of the water from each dish were assayed for activity.

One gram samples (fresh weight) of leaf and

root tissues were homogenized in a Potter-Elvehjem homogenizer under the following conditions.

1. Homogenized in distilled water at room temperature.
2. Homogenized in absolute ethanol at room temperature.
3. Homogenized in absolute ethanol at 0°C.
4. Steam blanched for 2 min. subsequent to homogenization in absolute ethanol at room temperature.
5. Lyophilized subsequent to homogenization in absolute ethanol at room temperature.

After homogenization the samples were centrifuged and the supernatant solution decanted. Each sediment was thoroughly extracted with absolute ethanol, centrifuged again and the supernatant added to the first extract respectively. These solutions were then evaporated to dryness under 15 mm. pressure and the residue taken up in 25 ml of distilled water for assaying.

RESULTS AND DISCUSSION

The cysts used for any individual assay were from a composite sample obtained from a single source in order to eliminate the difference in the viability of larvae in cysts collected at different times. Generally, during the hatching season duplicate assays did not vary from the mean by more than 10 percent.

All preparations of concentrates obtained possessed activity equivalent to or greater than that of the original leachings when diluted the appropriate amount with distilled water. For example, using duplicate assays the following average number of larvae hatching per 100 cysts were obtained: Distilled water, 200; original leaching, 600; concentrate-A (concentrated 4×10^4 times) diluted 4×10^4 times with distilled water, 805. Since a reliable quantitative assay for the factor was not available at the time these experiments were conducted the extent to which the preparations could be diluted and still exhibit hatching activity was not determined.

It has been observed that caution must be exercised during the process of concentrating solutions of the factor because of its lability towards heat and alkali. These properties are in accordance with those reported for eclepic acid.

The hatching factor was further concentrated by the technique of paper chromatography. Aqueous phenol, 80 percent, was found to be a satisfactory solvent for developing the chromatograms. Ascending developments with this solvent gave considerably sharper separations than did descending developments. Fig. 1 shows the distribution of activity on a typical strip when concentrate-A was developed for a distance of 19¼ inches at 25°C. using the ascending technique with the above solvent. The highest activity was found in the seventeenth segment, corresponding to a R_F value of 0.84. The average R_F value of six determinations was 0.84 ± 0.066. Weight determinations of the dried eluates from the various segments indicated that most of the solids remained in segments 2 to 5, inclusive. For example, after applying 950 μg to a strip, less than 10 μg of active residue was found to be eluted from the seventeenth segment.

The activity on the dry chromatograms was found to be quite rapidly destroyed upon exposure to air at room temperature. Elution immediately following the 24-hour air-drying period resulted in very little if any loss of activity. How-

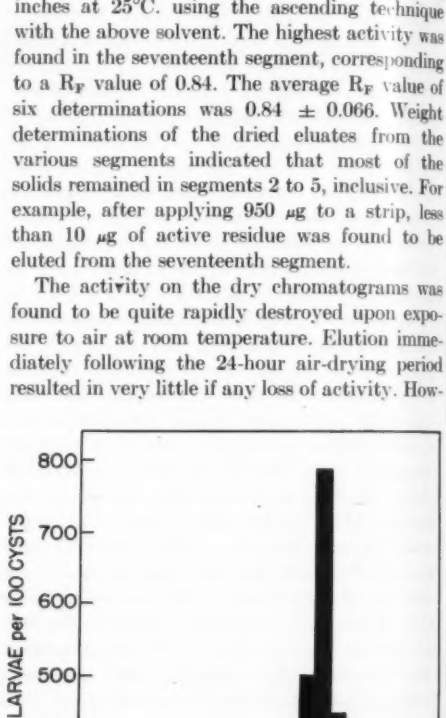

FIG. 1.—Distribution of activity on paper chromatogram of concentrate-A. A total of 950 μg of crude concentrate in 5.0 μl of water was applied to the paper. After development in 80 per cent phenol at 25° C. for a distance of 19¼ inches, the paper strips were dried and cut into one inch segments for elution and assaying. The values represented by X and Y indicate the activity of the most active segment after exposure to the laboratory atmosphere for 2 and 4 days, respectively, following the air-drying period.

ever, approximately 50 to 100 percent loss of activity from the most active segment occurred when the strips were permitted to remain exposed to the laboratory atmosphere for two and four days, respectively, after the drying period (see X and Y, Fig. 1).

The distribution of activity obtained when the crude concentrate prepared according to the method of Calam, Raistrick and Todd (1949), was chromatogrammed is shown in Fig. 2. The peak of highest activity corresponds to a R_F value of 0.83. When mixtures of this preparation and concentrate-A were chromatogrammed there was no change in the R_F value.

Concentration of the factor by continuous ether extraction of an aqueous sulfuric acid solution has been used by previous workers (Calam, Raistrick, and Todd, 1949). From the data presented in Table 1 it is apparent that the extracted material from concentrate-A possesses about the same activity as the non-extracted residue. However, the activity of more purified preparations obtained from paper chromatograms does not appear to be extracted with ether either from an aqueous sulfuric acid solution or directly from the paper chromatogram. The data presented in Table 2 are from a typical experiment in which the most active segments from four paper chromatograms were used. In this experiment 0.98 mg of concentrate-A was applied to each strip. In each treatment where ether was employed it was evaporated off after the extraction and the residue, if any, taken up in 40 ml of distilled water for duplicate assays. For continuous ether extraction the segments were eluted with 7.5 ml water and the solution acidified with 1.5 ml of 2N H_2SO_4. After the extraction period the aqueous phase was neutralized with NaOH and diluted to 40 ml for assaying. The inhibitory effect of Na_2SO_4 is shown by the lack of activity of solutions 2 and 3b (Table 2). This effect was not noted above due to the dilution employed. It is of interest to note the inactivity of the ether extracts (3a and 4a) and the high activity of the aqueous eluate (4b) from the strip which had previously been extracted with ether in a Soxlet apparatus for a period of 12 hours.

The presence of a hatching agent in tomato leaf tissue is indicated by the fact that water upon which leaf punches were floated was found to possess hatching activity. About twice the number of larvae were hatched in the presence of the water upon which illuminated leaf punches were floated for a period of one day as was hatched by an equivalent volume of leachings (see Table 3). At the end of two days illumination there was about an eight fold difference in the number of larvae hatched.

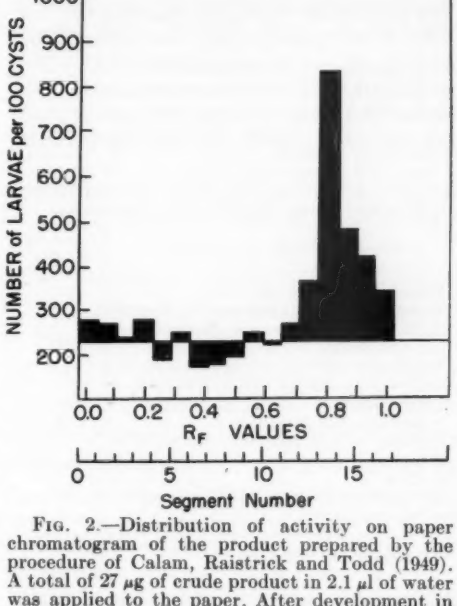

FIG. 2.—Distribution of activity on paper chromatogram of the product prepared by the procedure of Calam, Raistrick and Todd (1949). A total of 27 μg of crude product in 2.1 μl of water was applied to the paper. After development in 80 percent aqueous phenol at 25°C. for a distance of 16⅜ inches, the paper strips were dried and cut into one inch segments for elution and assaying.

The occurrence of a hatching stimulant in tomato leaves was further established by assaying extracts of the homogenized tissue. A comparison of the activity of leaf homogenates prepared under different conditions is presented in Table 4. The activity of root tissue homogenates prepared under the same conditions is also shown. Although the values for the number of larvae

TABLE 1.—ACTIVITY OF ETHER EXTRACTED MATERIAL FROM AQUEOUS SULFURIC ACID SOLUTION OF CONCENTRATE-A

Fraction	Weight	Concentration of solution assayed	Increase in number of larvae hatched above that of the blank
	grams	*μg/ml*	*per μg/ml of solids*
Ether phase	0.15	1.5	61
Aqueous phase	0.23*	3.5*	71

* Corrected for the Na_2SO_4 formed by neutralizing the H_2SO_4 previous to assaying.

hatched are quite low due to seasonal variations, there is a definite significant difference between several of the treatments and the distilled water blank. In the case of treatments 3, 4, and 5 (Table 4) the activity of the homogenates of both leaf and root tissue was equal to or greater than that of leachings. Steam blanching or lyophilizing the leaf tissue previous to homogenizing in absolute ethanol at room temperature appeared to be the most satisfactory treatment for this tissue. By far the most active root homogenates were obtained when the roots were homogenized in absolute ethanol at 0°C. Homogenates of the tissues in distilled water at room temperature showed no activity in the case of leaf tissue and a slight, if significant, activity in the case of root tissue.

TABLE 2.—ETHER SOLUBILITY OF CONCENTRATES OBTAINED FROM PAPER CHROMATOGRAMS

Treatment of most active segment	Larvae per 100 cysts*
1. Eluted with 7.5 ml distilled water	273
2. Eluted with 7.5 ml distilled water, 1.5 ml of 2N H_2SO_4 added and solution immediately neutralized with NaOH	12
3. Eluted and acidified as in 2, then continuously extracted with ether for a period of 12 hours:	
a. Ether phase	26
b. Neutralized aqueous phase	10
4. Extracted in Soxlet apparatus for a period of 12 hours:	
a. Ether	7
b. Water eluate of segment after ether extraction	244
Distilled water blank	24

* Average of duplicate assays.

TABLE 3.—ACTIVITY OF WATER UPON WHICH ILLUMINATED TOMATO LEAF PUNCHES WERE FLOATED

Assay solution	Larvae per 100 cysts*
Distilled water	1.5
Tomato leachings	16
Water upon which leaf punches were floated:	
1 day illumination	30
2 days illumination	130

* Average of duplicate assays.

TABLE 4.—ACTIVITY OF TOMATO TISSUE HOMOGENATES

Treatment*	Larvae per 100 cysts†	
	Leaf tissue	Root tissue
1. Homogenized in distilled water at room temperature	1.5	5.5
2. Homogenized in absolute ethanol at room temperature	5	8
3. Homogenized in absolute ethanol at 0°C.	11	35
4. Steam blanched, homogenized in absolute ethanol at room temperature	16	19.5
5. Lyophilized, homogenized in absolute ethanol at room temperature	16.5	11

Tomato leachings; 11 larvae per 100 cysts.†
Distilled water; 2 larvae per 100 cysts.†
* One gram (fresh weight) of tissue used in each preparation.
† Average of duplicate determinations.

SUMMARY

A method for obtaining a concentrate of the golden nematode hatching factor has been described.

By employing the technique of paper chromatography the factor was found to have a R_F value of 0.84 when 80 percent aqueous phenol was used as the solvent.

In a fairly pure state the factor was found to be ether insoluble.

A hatching agent has been shown to be present in leaf tissue as well as in root tissue of the tomato plant.

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RUSSELL, P. B., TODD, A. R., and WARING, W. S. *The potato eelworm hatching factor. 4.* Solanum nigrum *as a source of the potato eelworm hatching factor.* Biochem. Journ. **45**: 528:–530. 1949a.

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TRIFFITT, M. J. *On the bionomics of* Heterodera schachtii *on potatoes with special reference to influence of mustard on the escape of larvae from cysts.* Journ. Helminth. **8**: 19–48. 1930.

BOTANY.—*Realignments in the Bromeliaceae subfamily Tillandsioideae.* LYMAN B. SMITH, Department of Botany, U. S. National Museum, and COLIN S. PITTENDRIGH,[1] Department of Biology, Princeton University.

It has long been evident that no author has been consistent or logical in delimiting the genera of the subfamily Tillandsioideae of the Bromeliaceae. Virtually all useful phylogenetic characters are limited to the petals, stamens, and pistil, yet available material is so frequently inadequate in these parts, that there is a tremendous temptation to base genera on other characters. The assumption has been that certain habital characters are correlated with floral ones. This is true in a single instance, the absence of spines on the leaves of the Tillandsioideae. All other correlations in the subfamily are incomplete to begin with as in the case of the distichous arrangement of flowers that partially characterizes *Tillandsia* and *Vriesia*, or else they have broken down with the discovery of additional species.

We do not believe in making changes on well established systems such as the latest monograph of the family (Mez in Engler, Das Pflanzenreich IV. **32**) unless something demonstrably better can be offered, but the three genera noted below, *Thecophyllum* André, *Cipuropsis* Ule, and *Chirripoa* Suesseng., are now useless even in an artificial system. Although the generic position of many species must remain in doubt until good flowers are obtained, we are transferring all species on the basis of such evidence as is available. We preface our treatment of *Thecophyllum* and *Cipuropsis* by a concept of *Vriesia* Lindley emended appropriately to include these entities in the sense used by Mez in his last monograph. *Guzmania* requires no emendation to accommodate *Thecophyllum* in the original sense of André.

Vriesia Lindl. emend. Smith & Pittendrigh

Inflorescentia simplex vel paniculata, ea paniculata cum bracteis primariis vel parvis et inconspicuis vel conspicuis et ramos plus minusve obtegentibus; sepalis liberis; petalis vel in tubum brevem sepalis valde superatum connatis vel omnino liberis, appendiculatis; ovario supero vel paulo infero.

Lindley's type species, *V. psittacina*, is gamopetalous, but this fact has been overlooked and the genus characterized as polypetalous, as will be detailed in another paper. As defined above, *Vriesia* contains all the species of the Tillandsioideae with a primary type of gamopetaly, that is, with petals truly fused or connate and not merely agglutinated and more or less interlocking as in the secondary type that characterizes *Guzmania* and *Mezobromelia*. Since it also contains polypetalous species, its basic character remains its appendaged petals.

Thecophyllum André

(Structure of corolla noted where known)

Theccophyllum André, Bromel. Andr. 107. 1889 = **Guzmania** R. & P. Fl. **3**: 37. 1802, in all probability. Of the two original species, the first, *T. wittmackii*, is undoubtedly a *Guzmania*, while the second, *T. poortmanii*, very likely is also although its corolla is still unknown to us. See below.

Thecophyllum André emend. Mez, Bull. Herb. Boiss. II. **3**: 131. 1903 = **Vriesia** Lindl. Bot. Reg. **29**: *pl. 10*. 1843.

T. acuminatum L. B. Smith, Contr. Gray Herb. **117**: 30, *pl.* 2, *figs. 28, 29*. 1937 = **Vriesia attenuata** Sm. & Pitt. nom. nov. Not *Vriesia acuminata* Mez & Werckle, Bull. Herb. Boiss. II. **4**: 868. 1904. Petals appendaged—LBS.

[1] This author acknowledges assistance in the course of his work from the Eugene Higgins Memorial Fund, Princeton University.

T. angustum Mez & Wercklé, Bull. Herb. Boiss. II. **4**: 1121. 1904 = **Guzmania donnellsmithii** Mez ex Donn. Smith, Bot. Gaz. **35**: 9. 1903. Petals naked, agglutinated—LBS.

T. balanophorum (Mez) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903. *Guzmania balanophora* Mez in DC. Monogr. Phan. **9**: 918. 1896 = **Vriesia balanophora** (Mez) Sm. & Pitt. comb. nov. Petals appendaged, free—LBS.

T. balanophorum var. *subpictum* Suesseng. Bot. Jahrb. **72**: 291. 1942. From the description this appears to be the same as *T. lineatum* Mez & Wercklé. See below.

T. bracteosum Mez & Wercklé, Repert. Sp. Nov. Fedde **14**: 246. 1916 = **Vriesia bracteosa** (Mez & Wercklé) Sm. & Pitt. comb. nov. Not *Vriesia bracteosa* Beer, Bromel. 263. 1857, nomen in synonymy.

T. capitatum Mez & Wercklé, Bull. Herb. Boiss. II. **4**: 873. 1904 = **Vriesia capitata** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. capituligerum (Griseb.) L. B. Smith, Contr. Gray Herb. **98**: 14. 1932. *Tillandsia capituligera* Griseb. Cat. Pl. Cub. 254. 1886 = **Vriesia capituligera** (Griseb.) Sm. & Pitt. comb. nov. Petals connate—CSP.

T. comatum Mez & Wercklé, Bull. Herb. Boiss. II. **4**: 871. 1904 = **Vriesia comata** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. cornuaultii (André) Mez, Engl. Pflanzenreich IV. **32**: 423. 1935. *Tillandsia cornuaulti* André, Énum. Bromél. 8. Dec. 13, 1888; Rev. Hort. **60**: 568. Dec. 16, 1888 = **Tillandsia turneri** Baker, Journ. Bot. **26**: 144. 1888. See L. B. Smith, Contr. Gray Herb. **104**: 82. 1934. Petals naked, free—André sketch.

T. crassiflorum Mez & Wercklé, Bull. Herb. Boiss. II. **3**: 138. 1903 = **Vriesia crassiflora** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. cylindraceum Suesseng. & Goeppinger, Bot. Jahrb. **72**: 292. 1942 = **Vriesia cylindracea** (Suesseng. & Goeppinger) Sm. & Pitt. comb. nov. The specific name is uncomfortably close to that of *V. cylindrica* L. B. Smith, Contr. U. S. Nat. Herb. **29**: 445. 1951, but we believe it is enough different to obviate the use of a new name.

T. discolor Mez & Wercklé, Repert. Sp. Nov. Fedde **14**: 246. 1916 = **Vriesia discolor** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. dussii (Mez) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903 = **Guzmania dussii** Mez in DC. Monogr. Phan. **9**: 923. 1896. See L. B. Smith, Contr. Gray Herb. **98**: 30, *pl. 5, figs. 13, 14*. 1932. Petals naked, agglutinated—LBS.

T. fastuosum (André) Mez, Engl. Pflanzenreich IV. **32**: 423. 1935. *Tillandsia fastuosa* André, Énum. Bromél. 8. Dec. 13, 1888; Rev. Hort. **60**: 568. Dec. 16, 1888 = **Vriesia capituligera** (Griseb.) Sm. & Pitt. See above. Petals connate—CSP.

T. gloriosum (André) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903. *Caraguata gloriosa* André, Énum. Bromél. 5. Dec. 13, 1888; Rev. Hort. **60**: 565. Dec. 16, 1888 = **Guzmania gloriosa** (André) André ex Mez in DC. Monogr. Phan. **9**: 922. 1896. See André, Brom. Andr. 48, *pl. 17C*. 1889, where the corolla is described as "breviter trilobata"; L. B. Smith, Caldasia **3**: 240. 1945. Petals naked, agglutinated—André figure.

T. hygrometricum (André) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903. *Caraguata hygrometrica* André, Énum. Bromél. 6. Dec. 13, 1888; Rev. Hort. **60**: 566. Dec. 16, 1888 = **Vriesia hygrometrica** (André) Sm. & Pitt. comb. nov.

T. insigne (E. Morren) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903. *Pepinia insignis* E. Morren ex Baker, Handb. Bromel. 142. 1889 = **Tillandsia insignis** (E. Morren) Sm. & Pitt. comb. nov. Petals free, naked—LBS.

T. irazuense Mez & Wercklé, Bull. Herb. Boiss. II. **3**: 138. 1903 = **Vriesia irazuensis** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. johnstonii Mez, Bull. Herb. Boiss. II. **4**: 872. 1904, as *johnstonei* = **Vriesia johnstonii** (Mez) Sm. & Pitt. comb. nov. Petals appendaged, free—CSP.

T. kraenzlinianum (Wittm.) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903 = **Guzmania kraenzliniana** Wittm. Bot. Jahrb. **11**: 62. 1890, where the corolla-tube is noted.

T. kupperi Suesseng. & Goepping. Bot. Jahrb. 72: 292. 1942 = **Vriesia kupperi** (Suesseng. & Goepping.) Sm. & Pitt. comb. nov. According to the International Rules, the above combination is not invalidated by *Vriesia kupperiana* Suesseng. Bot. Archiv Leipzig **39**: 384, *fig. 1*. 1939. Petals originally described as free and appendaged.

T. latissimum Mez & Wercklé, Bull. Herb. Boiss. II. **4**: 1122. 1904 = **Vriesia latissima** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. lazum Mez & Wercklé, Bull. Herb. Boiss. II. **4**: 1123. 1904 = **Vriesia diffusa** Sm. & Pitt. nom. nov. Not *Vriesia laxa* (Griseb.) Mez in DC. Monogr. Phan. **9**: 578. 1896.

T. lehmannianum Mez, Repert. Sp. Nov. Fedde **16**: 72. 1919 = **Guzmania mosquerae** (Wittm.) Mez in DC. Monogr. Phan. **9**: 924. 1896. See below.

T. lineatum Mez & Wercklé, Bull. Herb. Boiss. II. **4**: 875. 1904 = **Vriesia lineata** (Mez & Wercklé) Sm. & Pitt. comb. nov. Petals appendaged, free—LBS.

T. longipetalum (Baker) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903. *Tillandsia longipetala* Baker, Journ. Bot. **26**: 142. 1888 = **Guzmania longipetala** (Baker) Mez in DC. Monogr. Phan. **9**: 919. 1896. See L. B. Smith, Contr. Gray Herb. **104**: 75. 1934. Petals naked, agglutinated—LBS.

T. montanum L. B. Smith ex Yuncker, Field Mus. Pub. Bot. **17**: 319, *pl. 7*. 1938 = **Vriesia montana** (L. B. Smith) Sm. & Pitt. Journ. Washington Acad. Sci. **43**: 69. 1953.

T. mosquerae (Wittm.) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903. *Caraguata mosquerae* Wittm. Bot. Jahrb. **11**: 58. 1889 = **Guzmania mosquerae** (Wittm.) Mez in DC. Monogr. Phan. **9**: 924. 1896. See L. B. Smith, Caldasia no. **5**: 6. 1942.

Petals naked, agglutinated—LBS. Long corolla-tube noted in original description.

T. ororiense (Mez) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903. *Guzmania ororiensis* Mez in DC. Monogr. Phan. **9**: 917. 1896 = **Vriesia ororiensis** (Mez) Sm. & Pitt. comb. nov. Petals described by Mez as free and appendaged in making the combination and in emending *Thecophyllum*.

T. palustre (Wittm.) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903. *Caraguata palustris* Wittm. Bot. Jahrb. **11**: 58. 1889 = **Guzmania palustris** (Wittm.) Mez in DC. Monogr. Phan. **9**: 923. 1896. Corolla-tube noted in original description.

T. paniculatum Mez & Werckl., Bull. Herb. Boiss. II. **4**: 1123. 1904, as *panniculatum* = **Vriesia triflora** Sm. & Pitt. nom. nov. Not *Vriesia paniculata* (L.) Mez in DC. Monogr. Phan. **9**: 614. 1896.

T. pauperum Mez & Sodiro, Bull. Herb. Boiss. II. **4**: 876. 1904 = **Vriesia paupera** (Mez & Sodiro) Sm. & Pitt. comb. nov.

T. pedicellatum Mez & Werckl., Bull. Herb. Boiss. II. **3**: 136. 1903 = **Vriesia pedicellata** (Mez & Werckl.) Sm. & Pitt. comb. nov.

T. pennellii (L. B. Smith) Mez. Engl. Pflanzenreich IV. **32**: 422. 1935 = **Guzmania pennellii** L. B. Smith, Contr. Gray Herb. **98**: 30, *pl. 6, fig. 3*. 1932. Confirmed as a *Guzmania* by a subsequent collection (*Cuatrecasas, Schultes & E. Smith* 12743).

T. pictum Mez & Werckl., Bull. Herb. Boiss. II. **4**: 874. 1904 = **Vriesia picta** (Mez & Werckl.) Sm. & Pitt. comb. nov. Petals appendaged—Mez.

T. pittieri Mez, Bull. Herb. Boiss. II. **3**: 137. 1903 = **Vriesia notata** Sm. & Pitt. nom. nov. Not *Vriesia pittieri* Mez, Bull. Herb. Boiss. II. **3**: 135. 1903. Petals free, appendaged—Mez.

T. poortmanii André, Brom. Andr. 108. 1889, as *poortmani*; Mez, Bull. Herb. Boiss. II. **3**: 131. 1903 = **Guzmania poortmanii** (André) André ex Mez in DC. Monogr. Phan. **9**: 922. 1896, as *poortmani*. Long corolla-tube noted in original description.

T. rubrum Mez & Werckl., Bull. Herb. Boiss. II. **4**: 878. 1904 = **Vriesia leptopoda** Sm. & Pitt. nom. nov. Not *Vriesia rubra* (R. & P.) Beer, Bromel. 98. 1857.

T. sceptrum Mez, Bull. Herb. Boiss. II. **3**: 139. 1903 = **Guzmania gloriosa** (André) André ex Mez in DC. Monogr. Phan. **9**: 922. 1896. See L. B. Smith, Caldasia **3**: 240. 1945.

T. singuliflorum Mez & Werckl., Bull. Herb. Boiss. II. **4**: 870. 1904 = **Vriesia singuliflora** (Mez & Werckl.) Sm. & Pitt. comb. nov.

T. sintenisii (Baker) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903. *Caraguata sintenisii* Baker, Handb. Bromel. 145. 1889, as *sintenesii* = **Vriesia sintenisii** (Baker) Sm. & Pitt. comb. nov. Petals appendaged, free—LBS.

T. spectabile Mez & Werckl., Bull. Herb. Boiss. II. **4**: 873. 1904 = **Vriesia spectabilis** (Mez & Werckl.) Sm. & Pitt. comb. nov.

T. splitgerberi (Mez) Pittendrigh, Evolution **2**: 60. 1948. *Guzmania splitgerberi* Mez in DC. Monogr. Phan. **9**: 930. 1896 = **Vriesia splitgerberi** (Mez) Sm. & Pitt. comb. nov. Petals appendaged, connate—CSP.

T. squarrosum Mez & Sodiro, Bull. Herb. Boiss. II. **4**: 877. 1904 = **Guzmania squarrosa** (Mez & Sodiro) Sm. & Pitt. comb. nov. See L. B. Smith, Caldasia no. **5**: 7. 1942.

T. standleyi L. B. Smith, Contr. Gray Herb. **117**: 30, *pl. 2, figs. 30, 31*. 1937 = **Vriesia standleyi** (L. B. Smith) Sm. & Pitt. comb. nov. Petals appendaged—LBS.

T. stenophyllum Mez & Werckl., Bull. Herb. Boiss. II. **4**: 875. 1904 = **Vriesia stenophylla** (Mez & Werckl.) Sm. & Pitt. comb. nov.

T. turbinatum Mez & Werckl., Bull. Herb. Boiss. II. **4**: 1122. 1904 = **Vriesia turbinata** (Mez & Werckl.) Sm. & Pitt. comb. nov.

T. urbanianum (Mez) Mez, Bull. Herb. Boiss. II. **3**: 131. 1903. *Guzmania urbaniana* Mez in DC. Monogr. Phan. **9**: 920. 1896 = **Vriesia antillana** Sm. & Pitt. nom. nov. Not *Vriesia urbaniana* Harms, Notizblatt **12**: 532. 1935. Petals appendaged—LBS.

T. violascens Mez & Werckl., Bull. Herb. Boiss. II. **4**: 877. 1904 = **Vriesia violascens** (Mez. & Werckl.) Sm. & Pitt. comb. nov.

T. viride Mez & Werckl., Bull. Herb. Boiss. II. **4**: 872. 1904 = **Vriesia viridis** (Mez & Werckl.) Sm. & Pitt. comb. nov. Petals appendaged, free—LBS.

T. vittatum Mez & Werckl., Bull. Herb. Boiss. II. **4**: 871. 1904 = **Vriesia vittata** (Mez & Werckl.) Sm. & Pitt. comb. nov.

T. werckleanum Mez, Bull. Herb. Boiss. II. **3**: 139. 1903 = **Vriesia nephrolepis** Sm. & Pitt. nom. nov. Not *Vriesia werckleana* Mez. Bull. Herb. Boiss. II. **3**: 136. 1903.

T. wittmackii André, Brom. Andr. 107, *pl. 39B*. 1889: Mez, Bull. Herb. Boiss. II. **3**: 131. 1903 = **Guzmania wittmackii** (André) André ex Mez in DC. Monogr. Phan. **9**: 921. 1896. Petals naked, agglutinated—LBS.

André based *Thecophyllum* on two species with free sepals and fascicles of flowers in the axils of large primary bracts. On the basis of a subsequent collection (*Haught* 2897), we know that the first of these, *T. wittmackii*, has the flowers of a *Guzmania*. The description of the second species, *T. poortmanii*, was based on Poortman's sketch of the plant, and as this indicated a long and exserted corolla-tube, there is little doubt that it also is a *Guzmania*.

In 1896, in his first monograph of the Bromeliaceae (DC. Monogr. Phan. **9**), Mez reduced *Thecophyllum* to a subgenus of *Guzmania*, adding 12 more species to the concept and dropping the character of free sepals.

In 1903, Mez discovered that one of these added species, *G. ororiensis*, had the flowers not of a *Guzmania* but of a *Vriesia*. Whereupon he re-

moved them all from *Guzmania* and resurrected *Thecophyllum* as a genus related to *Vriesia* but differing in its aborted branches.

From then until his second monograph (Engler, das Pflanzenreich IV. **32**), Mez added 33 more species including 15 with "ramulis manifestis." These last contradicted André's original basis and required a complicated redefinition of the genus. Although L. B. Smith had reduced the comparably artificial genus, *Sodiroa* (Contr. Gray Herb. **104:** 73), and demonstrated that several supposed species of Mez's *Thecophyllum* were in reality *Guzmania*, he continued with considerable inconsistency to follow Mez's lead in maintaining *Thecophyllum* as a genus (Pflanzenreich IV. **32:** 599–600).

In reducing Mez's concept of *Thecophyllum* to *Vriesia*, we note that so far as flowers are available, all species show the included stamens of the section *Xiphion*, and most of them have also the thick coriaceous sepals so common in this section. As it does not seem possible to separate Mez's *Thecophyllum* as a whole from the previously recognized species of section *Xiphion*, there is no point in trying to maintain it in an infrageneric category. Its merging with section *Xiphion* is logical from a geographical standpoint also, as that is the only section whose area completely surrounds it.

Cipuropsis Ule

Cipuropsis Ule, Verhandl. Bot. Ver. Brandenburg **48:** 148. 1907; Mez, Engl. Pflanzenreich IV. **32:** 598. 1935 = **Vriesia** Lindl. Bot. Reg. **29:** *pl. 10.* 1843.

C. subandina Ule, Verhandl. Bot. Ver. Brandenburg **48:** 149. 1907. *Tillandsia subandina* (Ule) Mez ex L. B. Smith, Contr. Gray Herb. **98:** 16. 1932; in Macbride, Fl. Peru, Field Mus. Pub. Bot. **13:** 556. 1936. = **Vriesia subandina** (Ule) Sm. & Pitt. comb. nov.

The genus *Cipuropsis* was erected by Ule to accept his species *subandina* which he observed had not only petal-appendages but also a gamopetalous corolla. We show above that no real justification existed for such action since *Vriesia psittacina*, the type of Lindley's genus, has the petals both appendaged and joined. Ule clearly took at face value Mez's polypetalous definition of *Vriesia*.

L. B. Smith's transfer of the species to *Tillandsia* was according to Mez's supposed distinction between petal-scales of *Vriesia* with a horizontal line of attachment and vertical calli with auricled apices found in some species formerly placed in *Tillandsia* (see Contr. U. S. Nat. Herb. **29:** 430). The character of gamopetaly was either overlooked or attributed to faulty observation. Later, in his last monograph, Mez accepted *Cipuropsis* as a distinct genus.

As Ule's specimen is not available it is not possible to decide which type of gamopetaly is involved, the primary or true fusion which would make *Cipuropsis* a synonym of *Vriesia* or the secondary or agglutination type which would cause it to replace the later *Mezobromelia*.

Two characters of *Cipuropsis* incline us to place it with *Vriesia* rather than with *Mezobromelia*, the shortness of its corolla-tube and the distichous arrangement of its flowers. In *Vriesia* the corolla-tube, when present, is much shorter than the sepals, in *Cipuropsis* it is described as little more than a fourth as long as the sepals, but in *Mezobromelia* it equals them. In *Vriesia* the flowers are two-ranked with very few exceptions and they are two-ranked in *Cipuropsis*, but not in *Mezobromelia*.

Chirripoa Suesseng.

Chirripoa Suesseng. Bot. Jahrb. **72:** 293, *pl. 4, fig. 11*, 1942 = **Guzmania** R. & P. Fl. Per. **3:** 37. 1802.

C. solitaria Suesseng. Bot. Jahrb. **72:** 293, *pl. 4, fig. 11*, 1942 = **Guzmania polycephala** Mez & Wercklé, Repert. Sp. Nov. Fedde **14:** 254. 1916; L. B. Smith in Woodson, Fl. Panama, Ann. Mo. Bot. Gard. **31:** 116. 1944.

The genus *Chirripoa* is a prime example of the confusion involved in making genera on habital characters, since the author in noting its affinities, compared it to genera in all three subfamilies of the Bromeliaceae. In fact he was so much in doubt that he published it as "nov. genus ad interim" indicating that the name was merely a means of noting the species until its genus could be discovered.

We find that the description and plate of *Chirripoa solitaria* agree closely with *Guzmania polycephala* with one exception. The description gives a greater length for the sepals than for the floral bracts. However, the illustration does not show exserted sepals and we can only suppose that through some error only the exposed apex of the floral bract was measured, disregarding the base covered by the bract below.

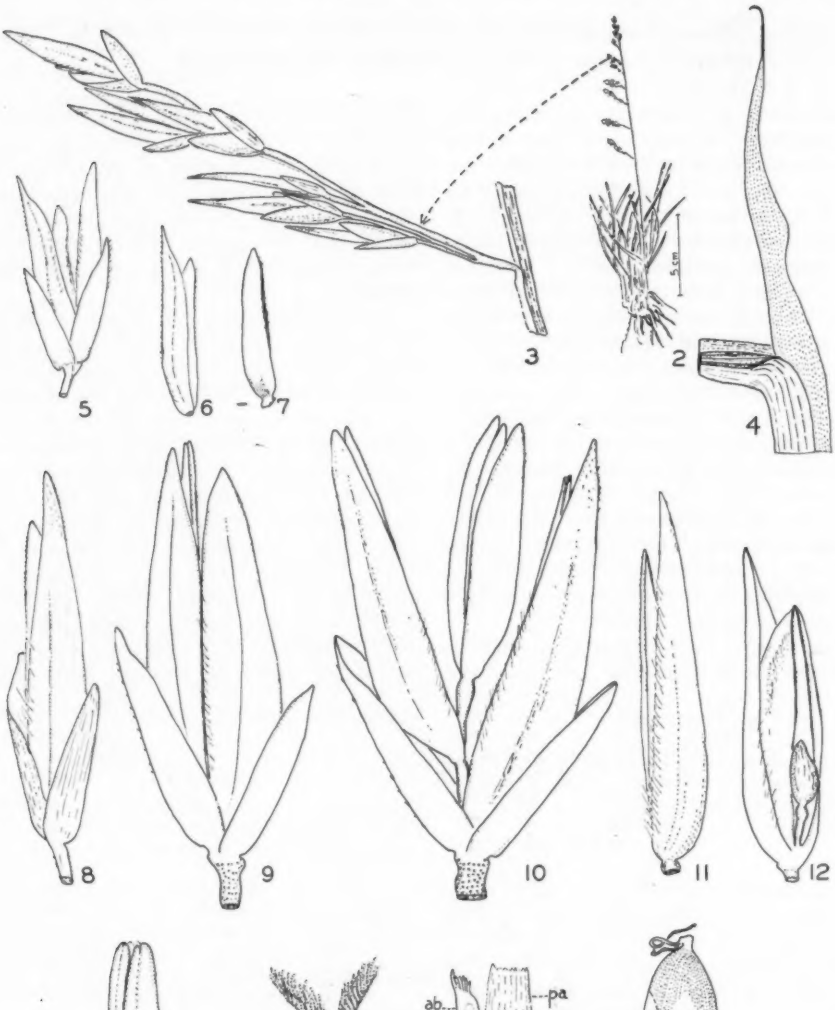
BOTANY.—Chaboissaea ligulata *Fourn.: A Mexican grass*, ERNEST R. SOHNS, U. S. National Museum. (Communicated by Agnes Chase.)

Chaboissaea, a monotypic genus of the tribe Festuceae, is relatively unknown. The genus was described by Fournier (1886) from material collected by Virlet in San Luis Potosí. A portion of the type in the U. S. National Herbarium bears these data: "Chaboissaea ligulata Fourn. Mexique. Prov. de San Luis. Coll. Virlet d'Aoust 1851." This species was collected a second time in 1910 by A. S. Hitchcock "No. 7693, along railway, Sanchez, Chihuahua, Oct. 12, 1910. Alt. 8000 ft." The writer collected this grass at three stations near San Felipe, Guanajuato, in October 1952 (Fig. 1). These plants were growing in hard, rocky, clay soil on the banks of dry irrigation ditches and on the rocky slopes of Cerro del Fraile. Associated species were *Eragrostis diffusa* Buckl., *E. plumbea* Scribn., *Panicum vaseyanum* Scribn., and *Andropogon hirtiflorus* var. *feensis* (Fourn.) Hack.

In its natural habitat this grass suggests a species of *Muhlenbergia* or *Eragrostis*. Perhaps this is the reason it has been infrequently collected. The purpose of this paper is to review the history of the genus and, with additional data from new material, to supplement the original description. It is hoped that this species will be represented more frequently in grass collections from Mexico.

Most taxonomists, after Fournier, treated the genus as a member of the tribe Agrostideae. *Chaboissaea* belongs in the tribe Festuceae. Hackel (1890) listed the genus at the end of his work among the doubtful genera, and he assumed that the Festuceae was the correct tribe. Lamson-Scribner and Merrill (1900) misapplied the name and transferred it to *Muhlenbergia ligulata*, citing two Palmer specimens, nos. 731 and 948 from Durango, these later described as *Muhlenbergia subbiflora* Hitchc. Hitchcock (1913) accepted Lamson-Scribner and Merrill's relegation of *Chaboissaea ligulata* to synonymy under *M. ligulata*. Bews (1929)

FIG. 1.—Map of northern Mexico. Collection localities are indicated by black dots. Type material was collected in San Luis Potosí, no precise locality given.



FIGS. 2–16.—*Chaboissaea ligulata* Fourn.: 2, Habit sketch of plant; 3, branch of inflorescence; 4, ligule; 5, 6, and 7, spikelet, floret, and palea, respectively, from the type specimen; 8, 9, and 10, one-, two-, and three-flowered spikelets; 11, floret; 12, floret showing rachilla and aborted floret; 13, anther; 14, pistil; 15, base of floret showing one lodicule (lod), palea (pa), rachilla (ra), and aborted floret (ab); 16, caryopsis. (Fig. 3–7, ×7; 8–16, ×22.) (Drawn from Sohns, nos. 411 and 446, deposited in the U. S. National Herbarium.)

lists the genus as a synonym of *Muhlenbergia*. Conzatti (1946) placed the genus in the Agrostideae and referred the species to *Muhlenbergia ligulata*.

Fournier's (1886) generic description was brief: "Spiculis bifloris, flore inferiore hermaphrodito, superiore minori sterili, paleis integris." One species, *C. ligulata*, was described (and illustrated) as follows: "Culmi glabro filiformi, foliis linearibus mediocribus, ligula lanceolata exserta longa fissa; panicula 10″ longa, contracta, radiis longis compositis alternis remotis basi nudis, spiculis bifloris; glumis inaequalibus, superiore majore; flore inferiore in callo insidente, hermaphrodito, palea inferiore ampla acuminata superiorem superante, margine ciliata, superiore breviter mucronata, staminibus 3, stylis longis, stigmatibus plumosis; flore superiore pedicellato, breviore et angustiore, palea inferiore acuta."

The following emended description is based on my collections from Guanajuato. It is evident that the genus belongs in the tribe Festuceae.

Perennial, caespitose (Fig. 2); culms 10–45 cm tall, glabrous; nodes glabrous; leaves mostly basal; sheaths keeled, glabrous, striate, margins hyaline, shorter than the upper internodes; ligule prominent (Fig. 4), membranous, up to 1 cm long, tip attenuated and splitting when dry; blades 3–12 cm long, glabrous on the lower and scabrous on the upper surface, folded when dry; inflorescence exserted and standing out prominently above the basal blades (in small plants), 6–12 cm long, branches appressed-ascending at first, later spreading; spikelets appressed and clustered along the branches, base of branches naked for 0.3–1 cm, margins scabrous (Fig. 3); lowermost branches longest (2–3.5 cm long), hence inflorescence pyramidal, branches distant, lower two 1–2 cm apart; spikelets 1–3 flowered (if 1-flowered the rachilla prolonged as a minute stipe), plumbeous, lowermost spikelets with one floret (and an aborted floret (fig. 12 and 15) or sometimes only a rachilla joint), those spikelets in center of branch and toward the end with two or three florets, 2–3.5 mm long (average length of 30 spikelets: 3 mm); first glume 1–2.2 mm long (average length of 30 first glumes: 1.4 mm), 1-nerved, thin, plumbeous, scaberulous; second glume 1.2–2.3 mm long (average length of 30 second glumes: 1.7 mm), otherwise like the first glume; lemma of the first floret 2.1–3.3 mm long (average length of 30 lemmas of first florets: 2.8 mm), 3-nerved, lateral nerves indistinct, scabrous on the keel and scaberulous over the back, sparingly pilose on the margins (margins of the lemma of the first floret more pilose than the margins of lemmas of the second and third florets); palea about 1 mm shorter than the lemma, 2-keeled, scabrous on the keels toward the tip, in mature spikelets clasping the caryopsis and standing out prominently from the lemma (Fig. 12); lodicules 2, 0.5–0.8 mm long (Fig. 12); stamens 3 (Fig. 13), about 1.5 mm long (measurements made on stamens of the first floret); styles relatively thick, short, separate at top of ovary; stigmas 2, plumose and curly (Fig. 14), exserted laterally during anthesis; caryopsis light brown, 1.4 mm long, oblong (Fig. 16).

Summary.—Chaboissaea ligulata Fourn., a little known grass from Mexico, is redescribed and illustrated. The species was described from material collected in San Luis Potosí in 1851, precise locality not given. It is represented by a single collection from Sanchez, Chihuahua (1910) and by three collections from San Felipe, Guanajuato (1952). The grass belongs in the tribe Festuceae. Significant additions to the original description are the following: Perennial; spikelets 1–3 flowered; glumes 1-nerved; lemmas 3-nerved, and florets with 2 lodicules.

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ZOOLOGY.—Thysanopoda spinicaudata, *a new bathypelagic giant euphausiid crustacean, with comparative notes on* T. cornuta *and* T. egregia. EDWARD BRINTON, Scripps Institution of Oceanography,[1] La Jolla, Calif. (Communicated by Fenner A. Chace, Jr.)

The bathypelagic giant euphausiids are taken here to include Crustacea belonging to the order Euphausiacea which live planktonically at great depths in the ocean, commonly below 2,000 meters. These giants among euphausiids are little known, probably owing to the fact that they are not abundant and live below the range of sampling of ordinary plankton-collecting gear. It is also possible that they are fast swimmers and are able to escape most nets. Together with *Thysanopoda spinicaudata*, n. sp., described below, the group includes at present only *Thysanopoda cornuta* Illig, 1905, and *T. egregia* Hansen, 1905. These euphausiids comprise a subdivision, "Group B," of the genus *Thysanopoda*, which was observed by H. J. Hansen (1912) to constitute a morphologically related unit. Four characters define this unit: a well-developed cervical groove separates the head area of the carapace from the thoracic region; the pseudoexopod of the first maxilla scarcely overreaches the outer margin of the joint, or does not overreach it at all; the endopod of the first maxilla is very long; the sixth abdominal somite is shorter than the fifth.

Euphausiids of this group are readily distinguished from other euphausiids, especially by means of the short sixth abdominal somite. Among the other species of Euphausiacea, only *Thysanopoda cristata* G. O. Sars, a midwater form which appears to be closely related to the giant euphausiids, possesses a sixth abdominal somite which is nearly as short as the fifth.

The euphausiids which live above a depth of about 500 meters are relatively small in size, reaching a maximum length of about 20 mm. There are two exceptions: the Antarctic *Euphausia superba* Dana which sometimes attains a length of 60 mm, and *Meganyctiphanes norvegica* (M. Sars) of the North Atlantic which reaches 40 mm. The euphausiids of the upper strata include numerous species belonging to nine genera, including one species *T. aequalis* Hansen, of Hansen's "Group A" of *Thysanopoda*.

The population which normally inhabits waters between about 500 and 2,000 meters is characterized by fewer genera and species, and by somewhat larger euphausiids. The largest of these, which sometimes attain a length of 50 mm, are *Thysanopoda acutifrons* Holt and Tattersall, and *T. cristata* G. O. Sars, both of which belong to Group A of *Thysanopoda*, and the monospecific *Bentheuphausia amblyops* (G. O. Sars).

The typical euphausiids below 2,000 meters are the bathypelagic giant euphausiids which belong to Group B of *Thysanopoda*. *Bentheuphausia*, and some other species whose major concentration is in upper layers, may, however, be present in this deep zone from time to time. The largest specimen in the Scripps Institution collections of the bathypelagic giant *T. egregia* is an adult female 62 mm long; the female specimen of *T. spinicaudata* measures 84 mm, and the largest known specimen of *T. cornuta*, a male collected by the Scripps Institution vessel *Horizon* in the southeastern Gulf of Alaska, is 95 mm long. These euphausiids not only attain a somewhat greater length than the Antarctic surface form *Euphausia superba*, but are also more broad. It is of interest to note, however, that both *E. superba* and the bathypelagic giant euphausiids inhabit waters which are colder than 2–3°C.

It has been necessary to describe *T. spinicaudata* from a single specimen. This is felt to be justified in view of the extreme scarcity of animals of this group. *T. egregia* Hansen (1905), was described from a single specimen captured near the insular slope of the Madeira Islands, while *T. cornuta* Illig (1905), was described from one animal from the Wallfisch Ridge of the Southeastern Atlantic. Illig (1905, 1930) and Hansen (1905, 1915) figure some of the features of *T. cornuta*, while Hansen (1905) has drawn the anterior part of *T. egregia*.

I am indebted to Prof. Martin W. John-

[1] Contributions from Scripps Institution of Oceanography, new ser., no. 652.

son, under whose supervision a study of the Pacific euphausiids is being carried out, for his criticism and suggestions.

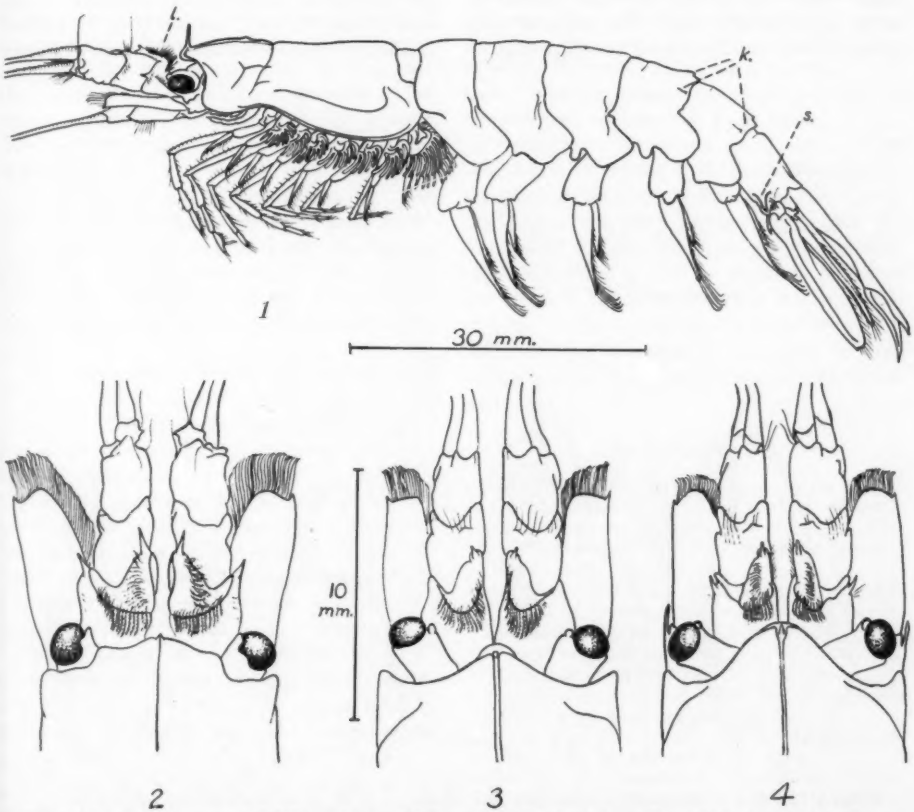
Thysanopoda spinicaudata, n. sp.

Figs. 1, 3, 6, 10, 11

Holotype.—Female; length 84 mm.

Diagnosis.—The carapace is without lateral denticles in the adult. A cervical groove crosses the dorsal part of the carapace. Lateral furrows (Fig. 1) are continuous with the cervical groove A longitudinal submarginal ridge extends along the lateral margin of the carapace posterior to the subvertical grooves. The lateral limits of the carapace are thickened to form marginal ridges. Viewed dorsally (Fig. 3), the anterior margin of the carapace is slightly convex. The dorsal anterior end of the frontal plate is armed with a strong vertical spine 1.4 mm in length. A low middorsal keel is present on the carapace, extending from the vertical spine to the cervical groove. The keel is interrupted near its midpoint by a short, obtuse prominence. Viewed laterally, the thickness of the frontal plate is less than the length of the dorsal spine. The anterior margins of the frontal plate, lateral to the spine, are slightly upturned.

The proximal end of the lower flagellum of the first antenna carries a dense tuft of long, colorless setae. The heavily setose, raised dorsal area of the first article of the peduncle of the first antenna (Fig. 1, 3) is equipped terminally with an acute tooth which is bulbous at its base and which is directed upward and laterally. The setose



FIGS. 1–4.—1, *Thysanopoda spinicaudata*, adult female: *k*, Keels on fourth and fifth abdominal somites; *l*, lappet on first article of antennular peduncle; *s*, spine on sixth abdominal somite. 2, *T. egregia*, anterior region, dorsal view. 3, *T. spinicaudata*, anterior region, dorsal view. 4, *T. cornuta*, anterior region, dorsal view.

part of the lappet of the first article is not produced posteriorly beyond its point of junction with the main part of the article; hence it does not overhang the trunk of the article. The scale of the second antenna is truncated distally (Fig. 3). A denticle is present at the antero-lateral angle.

T. spinicaudata derives its name from a heavy spine which is directed posteriorly and laterally from each side of the sixth abdominal somite (Fig. 1, s.). This spine orginates a short distance forward of the posterior margin of the somite and, together with that part of the pleuron adjacent to it, is situated so as to serve as a protective socket for the articulated base of the uropod.

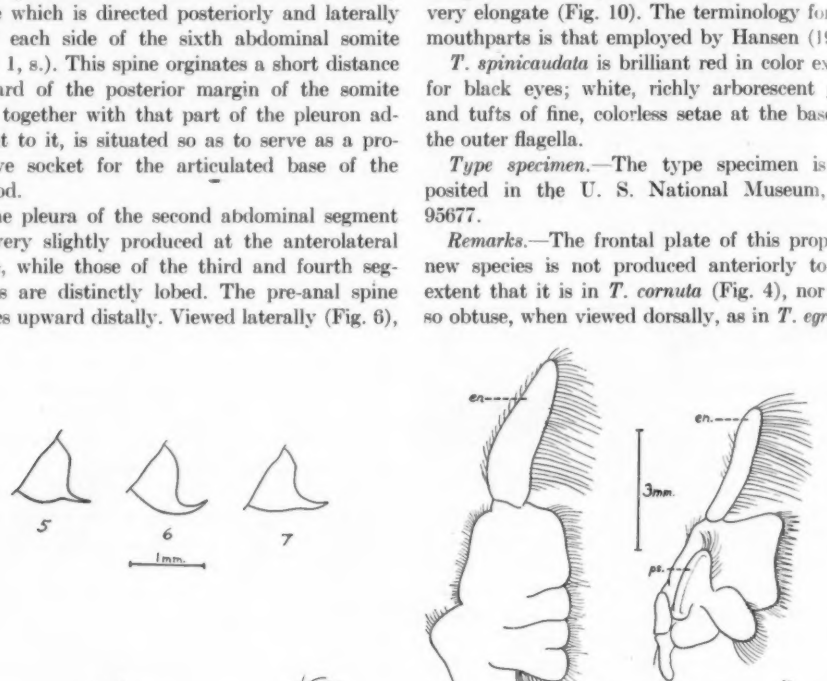
The pleura of the second abdominal segment are very slightly produced at the anterolateral angle, while those of the third and fourth segments are distinctly lobed. The pre-anal spine curves upward distally. Viewed laterally (Fig. 6), its lower margin traces a simple arc from the base of the spine to the acute tip.

The endopod of the first maxilla (Fig. 11) is slightly convex in outline along its inner longitudinal border and concave on its outer margin. The pseudoexopod of the first maxilla bears no indentation on its slightly thickened outer margin. The endopod of the second maxilla is very elongate (Fig. 10). The terminology for the mouthparts is that employed by Hansen (1925).

T. spinicaudata is brilliant red in color except for black eyes; white, richly arborescent gills, and tufts of fine, colorless setae at the bases of the outer flagella.

Type specimen.—The type specimen is deposited in the U. S. National Museum, no. 95677.

Remarks.—The frontal plate of this proposed new species is not produced anteriorly to the extent that it is in *T. cornuta* (Fig. 4), nor is it so obtuse, when viewed dorsally, as in *T. egregia*.



FIGS. 5–13.—5, *Thysanopoda cornuta*, pre-anal spine. 6, *T. spinicaudata*, pre-anal spine. 7, *T. egregia*, pre-anal spine. 8, *T. cornuta*, left second maxilla. 9, *T. cornuta*, left first maxilla. 10, *T. spinicaudata*, left second maxilla. *en.*, endopod. 11, *T. spinicaudata*, left first maxilla; *en.*, endopod; *ps*, pseudoexopod. 12, *T. egregia*, left second maxilla. 13, *T. egregia*, left first maxilla.

A small tubercle, comparable to but much smaller than the dorsal spine of *T. spinicaudata*, is present on the frontal plate of *T. cornuta*. Seen laterally, the thickness of the frontal plate of *T. cornuta* is much greater than the length of the tubercle. The frontal plate of *T. egregia* is curved downward. The middorsal keel on the carapace of *T. cornuta*, anterior to the cervical groove, is higher and more massive than in *T. spinicaudata*, while in *T. egregia* it is lower, broader, and poorly defined.

The proximal end of the lower flagellum of the first antenna of the males of *T. cornuta* and *T. egregia* is much thicker than that of the females of these two species and of *T. spinicaudata*. However, in each of the species the end carries a tuft of long setae which is more dense in males of *T. cornuta* and *T. egregia* than in females.

In *T. cornuta* and *T. egregia* the setose lappet of the first article of the peduncle of the first antenna is produced posteriorly, and slightly overhangs the trunk of the article. In the same two species, the distal margin of the scale of the second antenna is convex, when viewed dorsally (Figs. 2, 4), while in *T. spinicaudata* it is obtuse or truncated.

The fourth and fifth abdominal somites in all three species each bear three abbreviated keels: a mid-dorsal keel, flanked by a pair of subdorsal keels (Fig. 1). The posterior dorsal surface of the sixth somite is hollowed, forming a dorsolateral ridge along each side of the posterior half of the somite.

The ventral margins of the pre-anal spines of *T. egregia* and *T. cornuta* are indented (Figs. 5, 7), while in *T. spinicaudata* this margin is convex. The spines in the two former species show no sexual dimorphism.

Distinctions between these allied species are found also in details of mouthpart structure. The pseudoexopod of the first maxilla of *T. egregia* (Fig. 13) is, as in *T. spinicaudata*, slightly thickened along its outer margin. It is also indented near the midpoint of that margin, while the same margin of the pseudoexopod of *T. spinicaudata* is entirely convex. The pseudoexopod of the first maxilla of *T. cornuta* (Fig. 9) is flat and reaches to the outer margin of its joints.

The endopod of the second maxilla of *T. egregia* (Fig. 12) and of *T. cornuta* (Fig. 8) is half again as long as it is wide. The entire margin is convex in outline in *T. egregia*, while the inner margin of the same endopod of *T. cornuta* is concave in profile.

Larvae tentatively assigned to *T. cornuta* by Illig (1930) and Zimmer (1914) possess spiniform processes at the subdorsal posterior margins of the sixth abdominal somites. Compared with the latero-ventral spines which are subterminal to the sixth segment of *T. spinicaudata*, these are dorsolaterally situated and are present only in the larval (furcilia) stages of *T. cornuta*. The Scripps collections contain a series of the larvae which have the spiniform processes. Observations upon the development of the lateral groove complex on the carapace and of the tubercle on the frontal plate of the carapace indicate that these larvae belong to *T. cornuta*.

Type locality and collecting gear.—*T. spinicaudata* was collected by use of the Isaacs-Kidd Midwater Trawl at 2,200 meters in 4,070 meters of water, between 25°52′N, 114°40′W, and 26°00′N, 114°24′W. This is 75 miles west of the Baja California continental slope, adjacent to the southern shoulder of Rosa Bank.

Distribution.—*T. cornuta* and *T. egregia* have been taken at depths of 1,100–6,000 meters in the Atlantic, Pacific, and Indian Oceans. Larvae are known from 150–1,500 meters. *T. spinicaudata*, taken at 2,200 meters, probably has ecological requirements similar to those of the other two species. Extensive sampling in the Northeastern Pacific by Scripps Institution vessels indicates that the giant forms occur in deep waters seaward of continental shelves and borderland areas.

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ZOOLOGY.—*On the ranges of certain crayfishes of the* Spiculifer *group of the genus* Procambarus, *with the description of a new species*[1] (Decapoda: Astacidae).

HORTON H. HOBBS, Jr., University of Virginia. (Communicated by Fenner A. Chace, Jr.)

Six species of crayfishes belonging to the Spiculifer group of the genus *Procambarus* are known to inhabit lotic situations in Alabama, Florida, Georgia, and South Carolina. Of these, three have been described: *P. spiculifer* (LeConte, 1856:401), *P. versutus* (Hagen, 1870:51), and *P. suttkusi* Hobbs (1953:173). A description of the fourth is given below; however, before those of the other two are made larger series of both are needed.

Plotted on the accompanying map are the locality records available for the four described species. Since *P. spiculifer* and *P. versutus* are known from so many localities, a listing of the localities from which they have been collected seems superfluous; however, exact locality data have been given for *P. suttkusi* and are listed for the species described below.

The greatest gap in our knowledge lies in the region of the middle Chattahoochee and in the Alabama River system. It will be noted from map 1 that *P. spiculifer* is known from headwater streams of the Alabama River in Georgia as well as from localities near its mouth, but whether it occurs in the region between is not known. Specimens of *P. spiculifer* from over its entire known range have been examined rather carefully, but variations are few, and in no place where adequate series are available do any of these variations seem to be confined to local populations. A study of variations in *P. versutus* has been deferred until more specimens from central Alabama become available.

[1] Contribution from the Samuel Miller Biological Laboratories. I wish to thank Dr. E. C. Raney and Dr. D. C. Scott for their kindness in collecting for me the specimens on which this description is based, as well as for those on which many of the locality records indicated on the map are established.

Genus **Procambarus** Ortmann (1905)

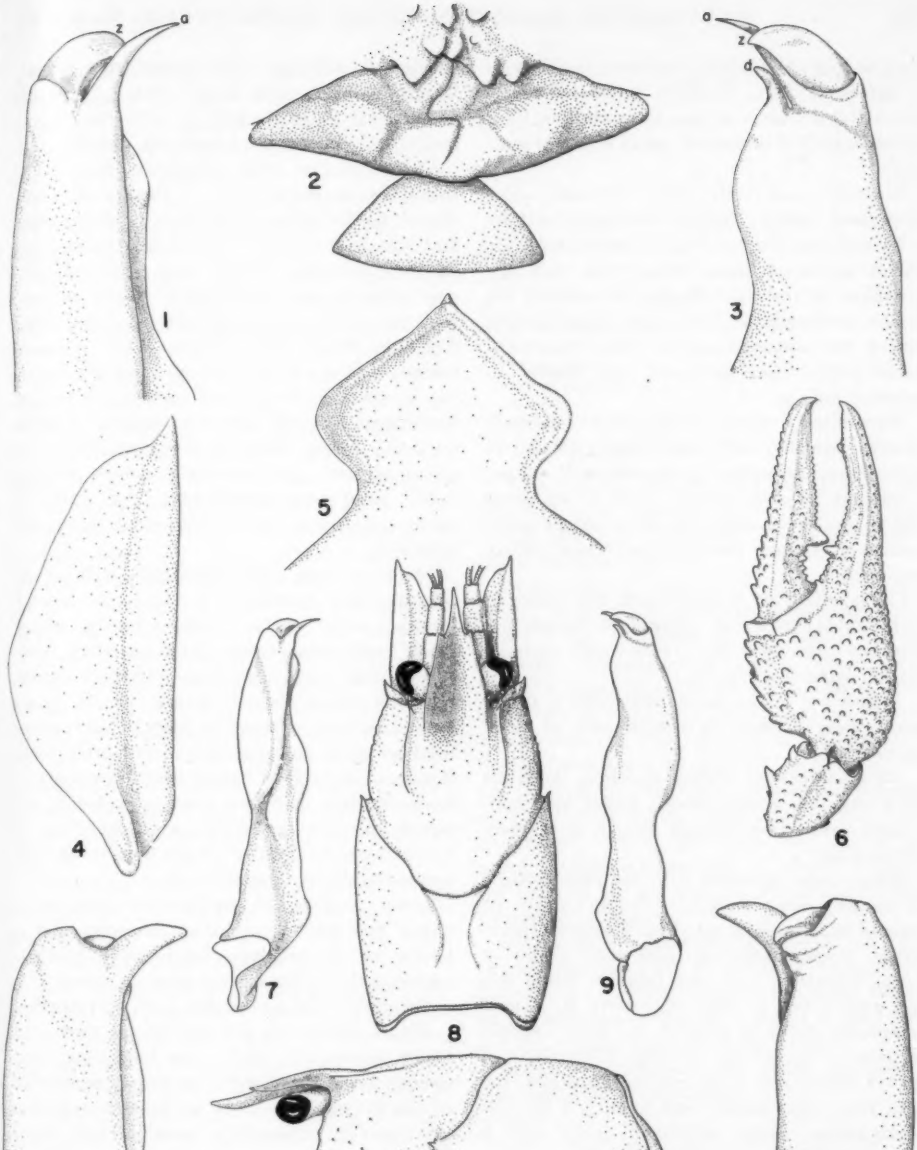
Procambarus raneyi,[2] n. sp.

Diagnosis.—Rostrum with lateral spines and without a median carina; areola relatively broad and short (about four times as long as broad and about 28 per cent of entire length of carapace); two lateral spines on each side of carapace. Male with hooks on ischiopodites of third and fourth pereipods; palm of chela of first form male not bearded but bearing a row of 7 to 9 tubercles along mesial margin. Postorbital ridges terminate cephalad in spines. First pleopod of first form male (Figs. 1 and 3) without a shoulder on cephalic margin and terminating distally in three distinct parts. Mesial process subspiculiform and directed caudodistad; cephalic process absent (as in *P. spiculifer*); caudal element consists of a small corneous curved tooth lying at the caudal base of the central projection; the compound central projection, the most conspicuous of the terminal elements, beaklike, corneous, and with its tip directed caudad; as is usual the centrocephalic process is much larger than the centrocaudal one. Annulus ventralis partially hidden by tuberculate extensions from the sternum anterior to annulus (Fig. 2).

Holotypic male, form I.—Body subovate, somewhat compressed laterally; abdomen slightly shorter than carapace (53.2–55.2 mm). Height and width of carapace in region of caudodorsal margin of cervical groove subequal; greatest width of carapace a little cephalad of caudodorsal margin of cervical groove (25.3 mm).

Areola relatively broad and short, about 4.4

[2] I name this species in honor of my good friend Dr. Edward C. Raney, of Cornell University, who has so graciously donated to me large numbers of crayfishes which he has collected while studying the fishes in the eastern part of the United States. Without his aid our knowledge of the crayfishes of the Atlantic slope would have been considerably hampered.



FIGS. 1–12.—*Procambarus raneyi*, n. sp. (Pubescence removed from all structures illustrated): 1, Mesial view of distal portion of first pleopod of holotype; 2, annulus ventral of allotype; 3, lateral view of distal portion of first pleopod of holotype; 4, antennal scale of holotype; 5, epistome of holotype; 6, distal three podomeres of cheliped of holotype; 7, mesial view of first pleopod of holotype; 8, dorsal view of carapace of holotype; 9, lateral view of first pleopod of holotype; 10, mesial view of distal portion of first pleopod of morphotype; 11, lateral view of carapace of holotype; 12, lateral view of distal portion of first pleopod of morphotype (*a*—mesial process; *d*—caudal process; *z*—central projection.)

times as long as wide with five or six punctations in narrowest part. Cephalic section of carapace about 2.3 times as long as areola (length of areola about 27.6 percent of entire length of carapace).

Rostrum moderately long, excavate; sides subparallel basally, slightly converging distally to base of long acumen which is set off by acute lateral spines. Acumen longer than half the remainder of rostrum. Margins of rostrum not swollen or conspicuously elevated. Upper surface with a few scattered minute setae. Subrostral ridges poorly developed and not evident in dorsal aspect.

Postorbital ridges prominent, shallowly grooved laterally, and terminating cephalad in acute spines. Suborbital angle weak and obtuse; branchiostegal spine strong. Two strong acute spines present on each side of carapace; upper surface of carapace punctate and lateral surface granulate.

Cephalic section of telson with two spines in each caudolateral corner. Margin of subtriangular epistome plumose with a very small cephalomedian spine (see Fig. 5).

Antennules of the usual form with a strong acute spine present on ventral side of basal segment.

Antennae extend caudad to telson. Antennal scale long; moderately broad; widest near midlength; outer distal margin with a moderately strong spine.

Right chela depressed with the palm inflated in middle; outer margin of hand concave at base of immovable finger. Hand entirely tuberculate. Inner margin of palm with a row of seven tubercles, with one tubercle below this row and a row of four just above it; a very prominent tubercle present on lower surface of palm at base of dactyl. Opposable margin of dactyl with a row of 23 rounded tubercles, the fifth from base largest and forming a distinct emargination; upper surface of dactyl with a low rounded submedian longitudinal ridge flanked on proximal two-thirds by tubercles and distally by setiferous punctations; mesial margin of dactyl with 12 tubercles; lower margin of dactyl similar to upper surface. Immovable finger with opposable margin concave and bearing an upper row of 24 rounded tubercles, sixth from base largest, and a lower row along distal half of 9 tubercles of which the sixth from base is largest; upper and lower surfaces similar to those of dactyl; although less tuberculate, lateral margin of immovable finger with a rounded longitudinal ridge flanked by tubercles proximally and setiferous punctations distally.

Carpus of first right pereiopod longer than broad; upper surface with a deep submedian furrow, flanked mesially by two rows of tubercles and laterally by less well defined rows; submedian furrow interrupted distally by a small tubercle near distal margin of podomere. Mesial surface with row of five tubercles, the third and fifth distinctly larger than others. Lower mesial margin with a row of four tubercles, the distal one of which is largest and corresponds to the mesial member of the usual two tubercles present on distal margin. Between these two rows is a group of four small tubercles. Lower surface with a large distal tubercle and a few scattered small ones. Lateral surface with small squamous tubercles.

Merus of first right pereiopods with small tubercles and scattered punctations on lateral surface; upper surface with tubercles along entire length, except near distal extremity, with two of the more distal ones distinctly larger than the others; mesial surface smooth proximally, with a few tubercles distally, and somewhat excavate along middle three-fourths, producing a longitudinal furrow near lower margin. Lower surface with two rows of spikelike tubercles, an outer one of 15 and an inner one of 15; scattered small tubercles are present between and to the side of these two rows.

Lower surface of ischiopodite bearing a mesial row of five spikelike tubercles and a lateral row of small tubercles; these are continuations of the corresponding rows on merus.

Basipodite and coxopodite with no tubercles.

Hooks present on ischiopodites of third and fourth pereiopods; hooks are both long and slender and only slightly recurved. Basipodite of fourth pereiopod bears no tubercle opposing the hook on ischiopodite; hooks of both third and fourth pereiopods extend proximad of distal end of their respective basipodites. Coxopodites of fourth and fifth pereiopods with caudomesial projections: that on fourth heavy and inflated, and that on fifth somewhat smaller and more sharply defined.

First pleopod extending to coxopodite of third pereiopod when abdomen is flexed. Tip terminating in three distinct parts (Fig. 3). Mesial process spiculiform and gently curved

caudodistad; cephalic process represented by a mere rounded lobe at cephalic base of central projection; caudal element consists of a corneous well-defined caudal process and a very small and poorly defined caudal knob; central projection, the most conspicuous of the terminal elements, corneous, broad (cephalocaudal axis), and directed caudolaterad.

Allotypic female.—The allotype differs only in a few minor details from the holotype; opposable margin of dactyl of right chela with 14 tubercles; opposable margin of immovable finger of chela with upper row of 10 tubercles and no lower row; inner surface of carpus of left chela with three major tubercles instead of two; two rows of tubercles on lower surface of merus with fewer tubercles than in holotype. See measurements for differences in proportions.

Annulus ventralis only slightly obscured in ventral aspect by small tubercles extending caudally from sternum immediately cephalad of annulus. Annulus subovate with the greatest length in the transverse axis; a transverse depression near midlength with high wall cephalad cut by a troughlike depression; caudomesial portion with a raised (ventrally) prominence. Sinus originates along median line near cephalic margin of annulus, extends caudodextrad and turns sharply sinistrad to cross the median line, and from there curving gently caudad to the midcaudal margin of the annulus (Fig. 2).

Morphotypic male, form II.—Differs from the holotype in the following respects: Abdomen slightly longer than carapace (52.8–50.8 mm); inner margins of palm of right chela with a row of three tubercles above the main row and only one below it; opposable margin of dactyl with a row of 18 tubercles, the fourth from base largest; opposable margin of immovable finger with upper row of 16 tubercles, fourth from base largest, and lower row of four. Lower surface of merus with mesial row of 14 tubercles and a very irregular lateral row. Hooks on ischiopodites of third and fourth pereiopods much reduced and neither extends proximad of basipodite of respective appendage. Prominences on coxopodites of fourth and fifth pereiopods much reduced.

First pleopod with three terminal elements visible (Figs. 10 and 12); the conspicuous mesial process directed caudally as are the less prominent caudal process and central projection.

Measurements.—As follows (in mm):

	Holotype	Allotype	Morphotype
Carapace:			
Height	25.2	23.1	24.0
Width	25.3	22.9	24.4
Length	55.4	47.1	51.0
Areola:			
Length	15.3	13.4	14.3
Width	3.7	3.7	4.0
Rostrum:			
Length	18.2	14.6	15.8
Width	8.5	7.6	8.2
Right chela:			
Length of inner margin of palm	19.4	10.1	13.5
Width of palm	20.5	12.2	13.8
Length of outer margin of hand	51.5	28.8	22.2
Length of dactyl	31.8	16.9	38.3

Type locality.—South fork of the Broad River, 1 mile south of Carlton on the Oglethorpe–Madison County line, Georgia (Savannah River drainage system).

Disposition of types.—The holotypic male, form I, allotypic female, and morphotypic male, form II are deposited in the United States National Museum (nos. 95124, 95125, and 95126, respectively). Of the 39 paratypes, one male, form I, one male, form II, and one female are deposited in the Museum of Comparative Zoology, and a similar series in the collection of Dr. G. H. Penn. One male, form I, is deposited in the United States National Museum and four males, form I, two males, form II, 15 females, 7 juvenile males, and 14 juvenile females are retained in my personal collection at the University of Virginia.

Relationships.—*Procambarus raneyi* has its closest affinities with *P. spiculifer* (LeConte); however, it may be distinguished from the latter by the structure of the first pleopod of the male and the annulus ventralis of the female.

Specimens examined.—All these specimens were collected from streams.

Savannah River Drainage

GEORGIA: *Madison–Oglethorpe* County line—9-1150-1, Anthony Shoals (south fork of Broad River) 1 mile south of Carlton [type locality], 4♂♂I, 1♂II, 7♀♀, 5 juv.♂♂, 11 juv.♀♀, D. C. Scott, coll.; 4-1550-2a, same locality, 2♂♂, D.C.S., coll. *Madison County*—4-1550-1a, Small ck., 5 miles east of Carlton, 1♀, D.C.S., coll.; 4-1550-3, Masons Creek, 11 mi. W. of Royston on Route 29, 1♂II, 1♀, D.C.S., coll.; U.S.N.M. no. 93253 (9/10/47), trib. of Broad River, 0.7 miles southwest of Danielsville on Route 29, 1♂I, E. I. Lachner, coll. *Elbert County*—

4-1550-2a, 2.5 miles east of Broad River on Route 77, 2♂♂II, 2♀♀, 1 juv.♂, D.C.S., coll.; 3-2751-5a, Morea Creek, 1.5 miles south of Nuberg on Route 77, 2♀♀, E. C. Raney, coll. *Stephens County*—4-947-2b, north fork Broad River, 3.7 miles west of Toccoa, 1 juv.♂, 1 juv.♀ E C.R., coll.

SOUTH CAROLINA: *Abbeville County*—3-2751-1b, Calhoun Creek, 7.6 miles east of Calhoun Falls on Route 72, 2♂♂I, 1 juv.♀, E.C.R. coll.; 3-2751-3, same locality, 1♂I, E.C.R., coll.; 3-2751-4, Long Crane Creek, 4.4 miles east of Abbeville, 1♀, E.C.R., coll.; 3-2751-6, Little River, 5.6 miles east of Calhoun Falls on Route 22, 1♂II, 2♀♀, 1 juv.♀, E.C.R., coll.

OCMULGEE RIVER DRAINAGE

GEORGIA: *Dekalb County*—3-2950-2, Flat Shoals on South River near Decatur, 4♂♂I, 4♀♀, E.C.R., coll.

Discussion.—*Procambarus raneyi* inhabits tributaries of the Savannah River in the Piedmont Province in Georgia and South Carolina and is known from a single locality in the headwaters of the Ocmulgee River (Altamaha River drainage) in Dekalb County, Ga. This latter locality, an isolated one, is of considerable interest, for here this species is surrounded by its nearest relative, *P. spiculifer* (see map 1), which is found in the Chattahoochee, lower Ocmulgee, and Oconee drainages. The simplest explanation as to how *P. raneyi* gained entrance into the headwaters of the Ocmulgee would involve transport by human agencies. There seems to be little reason to assume, however, that once introduced into a stream which is largely dominated by *P. spiculifer* it would be able to replace the latter. Certainly from an anatomical standpoint it has no obvious advantageous characteristics, and there are no data available concerning the reproductive capacities of either species. Although there is no geological evidence, nor are there other evidences, to support any other explanation for their presence here, it does not seem amiss to pose the question as to whether or not the Dekalb County population represents a relict fauna.

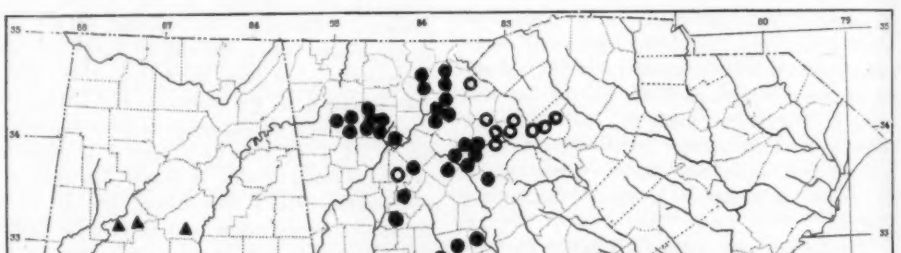


FIG. 13.—Map of locality records for four species of *Procambarus*.

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ZOOLOGY.—*New millipeds of the western States and Lower California*. H. F. LOOMIS, Coconut Grove, Fla.

For many years past there has been accumulating a number of interesting but undescribed millipeds in the writer's collection. These have not lent themselves to inclusion in systematic treatment of groups that have been prepared recently or are contemplated. Several of the species exhibit characters that affect the present concepts of the family or genus to which they belong and consequently are especially noteworthy. Types of species here described are deposited in the U. S. National Museum.

Cambala caeca, n. sp.

One broken male (type) from "inner area of bat cave," Wyatt Cave, and 12 females from Felton Cave taken "in association with bat guano" by O. G. Babcock, Sonora, Tex., 1922–23. U.S.N.M. no. 2087.

Diagnosis.—Although departing in several particulars, such as lack of eyes, the anterior segments forming a necklike constriction, and the presence of claws on the first male legs, from the characters associated with the genus, the gonopods are so definitely typical of *Cambala* as to require inclusion of the species there and cause modification of the generic concept involving the above characters.

Description.—Length 22 to 25 mm. Number of segments of females 46 to 48, male type with 54.

Head without eyes, smooth, the clypeus with 6 to 8 setae, the labrum with 12 to 14 setae; antennae with joint 2 longest, joint 6 broadest and next in length.

First segment as long as the next three together, anterior angle broadly rounded and flaring outward somewhat from the side of the head; posterior angle slightly produced backward; surface of segment smooth but with a fine raised rim along the lateral margin. Fig. 1.

Segments 2 and 3 with sides converging backward to form a noticeable necklike constriction; segment 2 entirely smooth above with segment 3 usually so, but infrequently dorsal crests are faintly evident near the back margin.

From segment 4 to the penultimate segment inclusive there are four strong, smooth, dorsal crests between the poriferous ones, the latter having the posterior half of the same thickness as the dorsal crests but the anterior half is two or three times as broad, slightly more elevated, and with the pore in the center. Sides of segments striate but the surface just below the upper stria elevated to form a noticeable ridge; prozonites crossed lengthwise by numerous thin, low, beaded ridges.

Last segment smooth, as long as the two preceding segments together.

Anal valves smooth, meeting in a groove. Preanal scale broad, slightly thickened and emarginate at middle and with an erect seta on either side; tab processes large, each with a single seta.

Gonopods as shown in Figs. 2 and 3.

First male legs 6-jointed, the first and second joints short but twice the width of the following joint; last joint not modified and with a normal claw. Legs 6 and 7 with joints 4 and 5 enlarged, the former with a large rounded lobe ventrally.

Remarks.—In Ent. News **63**: 10–11. 1952. Chamberlin described a new genus and species of cambalid from the same two caves and taken by the same collector as were the specimens above referred to the genus *Cambala*. In comparing the specimens before me with Chamberlin's generic and specific descriptions of *Eclomus* (*Eclytus*) *speobius* one is struck by the numerous points of similarity of the two species. *E. speobius*, however, is said to have dorsal carinae somewhat developed on segment 2 and on the succeeding segments "sharply elevated and complete", whereas specimens of *C. caeca* show segment 2 with no semblance of dorsal carinae and in only a few specimens do they appear as faint elevations near the posterior border of segment 3.

In other particulars the similarity is remarkably close but *E. speobius* is credited with but 41–43 segments whereas mature specimens of the present species have 46–54. Since no male characters whatever were mentioned for *E. speobius* it

may be inferred that the genus was founded on females, immature specimens or both. With the numerous specimens in both collections coming from the same very restricted locations it is most remarkable that in neither were both species represented. Should it be shown at a later date that but a single species is involved the rules of priority would require that *Eclomus* be placed as a synonym of *Cambala* and *caeca* would then become a synonym of *speobia*.

Orthoporus arizonicus, n. sp.

Two males, 1 the type, and a female collected at Patagonia, Ariz., in July 1949, by R. H. Peebles and sent to me alive. U.S.N.M. no. 2088.

Diagnosis. Closely related to *punctiliger* Chamberlin as indicated by the gonopods but the size is smaller, and more slender; the sculpturing of the segments, anal valves and preanal scale is simply punctate without rugae; and the first segment has but two lateral striae.

Description.—Length 85 to 88 mm, diameter 5 to 6 mm, number of segments 63 to 65. Living color cinnamon brown, with the posterior margin of the segments narrowly darker, legs and antennae also cinnamon brown.

Head with finely impressed sulcus on vertex; front coarsely, longitudinally rugose-punctate below but lessening above; clypeal fovoea 13 or 14; eyes separated by over one and a half times the length of an eye, composed of 53 to 56 ocelli in 7 transverse rows.

First segment (Fig. 4) with two prominent lateral striae only; anterior corner somewhat produced in the male.

All segments, as well as the anal valves and preannal scale, very finely punctate and without any impressed lines or rugosity; transverse sulcus strongly evident throughout, bowed forward around the pore which is a third of the way to the posterior margin; last segment rather acute at tip, considerably exceeded by the anal valves.

Gonopods as shown in Fig. 5.

Hiltonius palmaris, n. sp.

Two males, 1 the type, and a female collected by the writer in Palm Canyon, Palm Springs, Calif., December 4, 1919. U.S.N.M. no. 2089.

Diagnosis.—Apparently most closely related to *H. mimus* Chamberlin but with distinct differences in all parts of the gonopods and in the much larger coxal lobes of the third male legs.

Description.—Length of body 35 to 50 mm, width 4.3 to 6 mm; number of segments 48 to 49.

Head with frontal groove strong and wide, that of the vertex not so pronounced; eyes subtriangular, composed of 25 to 30 ocelli in 6 longitudinal rows; clypeal fovoea 4 to 5 on each side.

Sides of the first, second and third segments as shown in Fig. 6; the anterior margining rim of segment 1 broad; following segments with a fine median sulcus and a sharply marked transverse constriction on either side of which the surface is faintly convex; pore in front of the constriction but not touching it; midbelt with lateral sulcus faint or absent but that of the hindbelt broad and deep in front, diminishing caudally.

Last segment sharply rounded, in one specimen distinctly angulate; transverse impression faint. Anal valves quite evenly inflated, not more conspicuously so near the margins which meet in a shallow groove; surface punctate and with irregular wrinkles near the opening. Preanal scale broadly rounded and with longitudinal striations, more distinct near the hind margin.

Gonopods as shown in Figs. 7 and 8.

Coxae of third male legs as shown in Fig. 9.

Arinolus latus, n. sp.

A number of specimens, including the male type, were collected from beneath stumps of *Yucca arborescens* in Antelope Valley between Lancaster and Palmdale, Calif., January 8, 1928, by O. F. Cook. U.S.N.M. no. 2090.

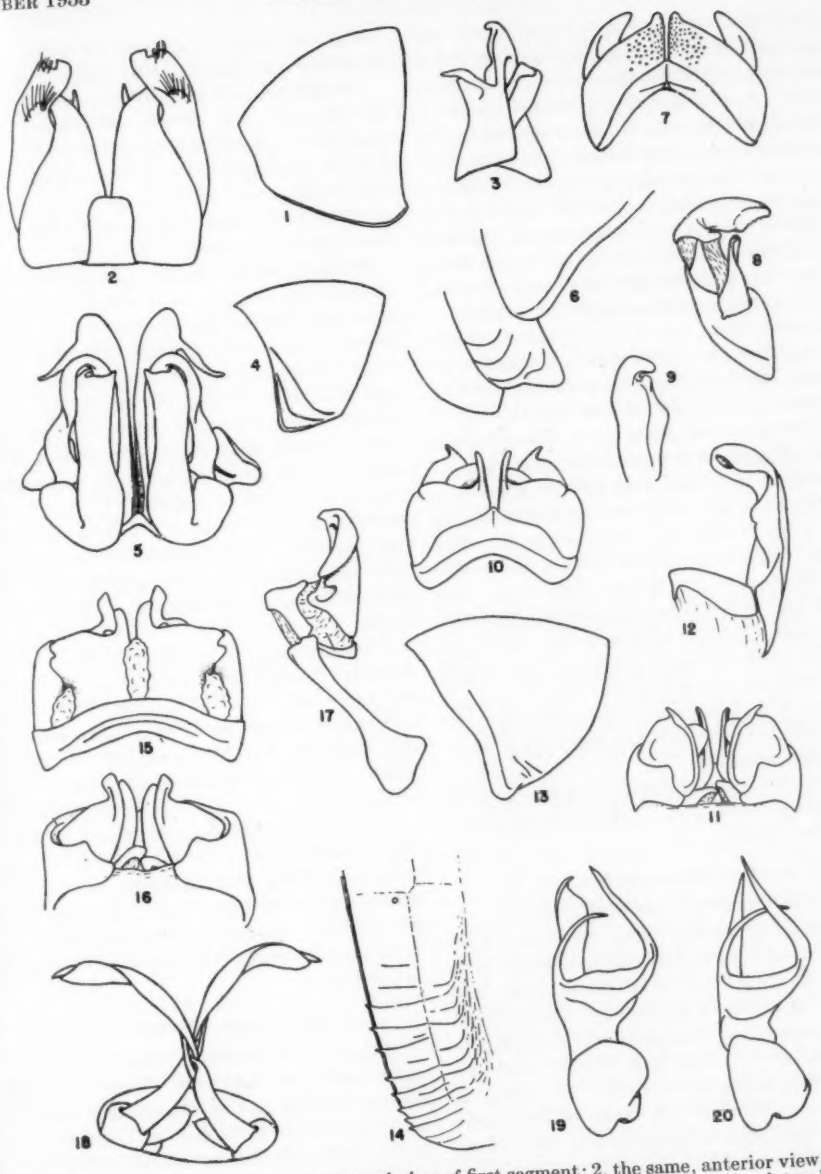
Diagnosis.—Distinguished from the other species by the gonopods, particularly the inner ones, and also by the stout body, thickened posterior margins of the segments, very broadly rounded last segment, and the living color.

Description.—Body very stout and abruptly constricted at the ends; 29 to 35 mm long and 3.5 to 4 mm thick, the females stouter than the males; segments 42 to 44.

Living colors very strongly shining black with the hindbelt almost golden yellow, semi-translucent. In alcohol the hindbelt changes to dull yellow.

Head with a deep median sulcus on the vertex, the surface of which is slightly rugose in contrast to the shining surface elsewhere; clypeus with 5 or 6 punctations each side; eyes inconspicuous, composed of about 24 to 26 low ocelli in 6 rows forming a rounded patch.

First segment with the margin from behind the eye to the lateral angle strongly raised, the angle a little more acute than in *torynophor* Chamb.



FIGS. 1–20.—1, *Cambala caeca*, n. sp., lateral view of first segment; 2, the same, anterior view of gonopods; 3, the same, lateral view of posterior gonopods; 4, *Orthoporus arizonicus*, n. sp., lateral view of first segment; 5, the same, anterior view of gonopods; 6, *Hiltonius palmaris*, n. sp., lateral view of segments 1, 2 and 3; 7, the same, anterior view of gonopods; 8, the same, lateral view of gonopods with inner gonopod extended; 9, the same, coxae of third male leg; 10, 11, *Arinolus latus*, n. sp., anterior and posterior views respectively of gonopods; 12, the same, anterior view of inner gonopod; 13, *Scobinomus serratus*, n. sp., lateral view of first segment; 14, the same, lateral view of lower side of mid- and hindbelt of segment 21; 15, 16, the same, anterior and posterior views respectively of gonopods; 17, the same, inner gonopod; 18, *Chipus unicus*, n. sp., posterior or ventral view of gonopods which are foreshortened in this aspect; 19, *Motyxia expansa*, n. sp., right gonopod; 20, *Motyxia exilis*, n. sp., right gonopod.

and decidedly more so than in *hospes* (Cook) and usually containing one or two rudimentary striae.

Segments with the transverse constriction shallow but evident, the pore located behind it; in lateral view the surface of the segments behind the constrictions is flatter than in the other species but the hind margins are decidedly thicker; lateral sutures usually not visible but occasionally faintly evident behind the pore on segments near the posterior end of the body; median sulcus visible on the posterior third of all segments from the first to the last inclusive, on the latter forming a conspicuous furrow on the apical portion; surface of fore and midbelts as in *torynophor*, the hindbelt punctate but less noticeably striate, except along the thickened hind margin.

Posterior end of body very abruptly constricted, the segments immediately preceding the last strongly telescoped. Last segment short, margin very much thickened, apex subtruncate, very much more broadly rounded than in the other species. Anal valves almost vertical and visible from above, much less inflated than in the other species, and with the margins meeting in a shallow groove. Preanal scale broadly truncate at the apex, the lateral margins noticeably emarginate.

Gonopods as shown in Figs. 10 to 12.

Segment 6 of the males conspicuously wider and longer than the adjacent segments and also wider than segment 1.

Males with coxae of legs 3 and 4 less produced than are those of 5, 6, or 7, which are much as in *hospes* but thicker.

Scobinomus, n. gen.

Genotype: *Scobinomus serratus*, n. sp.

Diagnosis.—Scobinae have been associated with many of the tropical rhinocricids but with none of the North American *Atopetholidae*. The presence of scobinae, though rudimentary, and emargination of the segments above them, in this genus indicate a distinct gap between it and all other known genera of the family. The gonopods bear some resemblance to those of *Tarascolus* Chamb. but the anteriorly exposed coxal joints of the posterior lobes and differently shaped inner gonopods are distinctive characters in addition to the external ones.

Description.—Body rather small and slender, from 10 to 12 times as long as broad; subclavate, the first four or five segments broader than the others.

First segment with the lateral angles narrowed and flaring away from the body, forming its widest part, and distinctly visible from above.

Second segment slightly narrower than the first segment and without an anterior ventral production. Segments 3, 4, and 5 gradually narrowing, after which the segments remain of uniform width to the posterior end of the body except that in the males segment 6 is expanded and nearly as wide as segment 2.

Midbody segments with a strong constriction through the midbelt, the surface behind it conspicuously convex; pore located nearly half way between the constriction and the back margin, immediately behind the suture separating the mid- and hindbelt, thus placing the pore in the latter. Scobinae present, represented by transversely striate areas usually apparent as far forward as segment 6; segments in the scobinate region of the body with the posterior border emarginate adjacent to each scobina of the ensuing segment. Ventral striations reaching about half way to the pore, the marginal angle below each striation carried back into a slender, acute tooth.

Last segment of normal length, the apex broadly rounded and not carried beyond the strongly convex anal valves.

Gonopods with ventral plate short, transverse, not produced at middle; coxal joints of posterior lobes extensively exposed on either side in front; inner gonopods with apical joint short and stout.

Legs long and slender, surpassing the sides of the body. Males with the first two pairs enlarged, the claws double the thickness and length of those on the other legs; coxae of third legs greatly elevated and with the apex bent backward; coxae of ensuing pregenital legs somewhat elevated but not reflexed.

Scobinomus serratus, n. sp.

Male type and three other specimens from 14 miles north of Ensenada, Lower California, January 7, 1925, and three specimens from Ceregas Canyon, 8 to 10 miles from Ensenada, January 5, 1925; collected by O. F. Cook. U.S.N.M. no. 2091.

Description.—Length 30 to 35 mm, width 2.5 to 2.8 mm; number of segments 42 to 46; males more slender than females.

Head with antennae quite slender, joint 2 slightly longest, joints 3 and 6 subequal and next in length, joint 1 slightly longer than joint 7; ocelli 30 to 33 in six series forming a circular

cluster; median furrow very faint on the vertex but strongly impressed on the clypeus.

First segment (Fig. 13) emarginate below the eye and with a broad thickened rim; lateral angles narrowly produced downward and flaring outward from the body and forming its widest part, the angles visible from above; surface of the angulation, behind the anterior rim, with 2 to 5 short striae reaching forward from the posterior margin.

Body not shining but with a dull sheen caused by minute reticulation of the entire dorsal surface; in addition there are a few fine punctations more apparent on the anterior end of the body and on the last segment; forebelt of all segments finely transversely striate; midbelt containing a broad transverse constriction that is lacking on the posterior segments; pore located in the anterior portion of the hindbelt which is strongly convex on constricted segments; scobinae, represented by large, triangular, transversely striate areas, as broad as long and lacking an anterior pit, are present from segment 6 or 7 to just beyond the middle of the body, the posterior margin of the segments in the scobinate region emarginate above each scobina of the succeeding segment; ventral striations reaching only halfway to the pores, the posterior marginal angle below each stria produced as a rather long slender tooth, these teeth present on all but four or five segments at each end of body (Fig. 14).

Penultimate segment almost entirely telescoped within the preceding segment, the last segment not telescoped, the apex produced and very broadly rounded but not exceeding the strongly convex anal valves which meet in a deep groove.

Gonopods as shown in Figs. 15 and 16, with a large soft, and fleshy mass above the middle of the ventral plate between the anterior lobes and with a similar fleshy mass on either side at the basal junction of the anterior lobe and the coxal joint of the posterior lobe. Anterior lobes subquadrate, strongly produced at the inner distal corner, each lobe enclosed on the outer side by the conspicuous coxal joint of the posterior lobe, outer joint of the latter rather small, subtriangular, with the apex produced. Inner gonopods as in Fig. 17, the outer joint short, stout, and excavated on the inner side.

Chipus, n. gen.

Genotype: *Chipus unicus,* n. sp.

Diagnosis.—Immediately distinguished from all other members of the family Chelodesmidae by the curious elongated and crossed gonopods which clasp the sides of the body.

Description.—Body strongly convex with lateral carinae more strongly projecting in the male; posterior angles rounded-obtuse, not produced backward except on two or three segments preceding the last; carinae of segment 19 greatly reduced in size and thickness and with the slightly produced posterior angles small and acute. Segment 1 with distinct raised margin on the sides in front.

Gonopods unique in that the principal or posterior divisions are long, slender, two-parted and crossing each other, curving forward and upward between legs 5 and 6 and extending halfway up the sides of the body to the lateral carinae.

Coxae of third male legs each with a hispid, tumid prominence on the ventral face.

Chipus unicus, n. sp.

A male (type) and female collected by A. Gibson, July 20, 1949, in forest of western white pine, western fir, larch, cedar, and hemlock on west fork of Emerald Creek, St. Joe National Forest, Idaho. U.S.N.M. no. 2092.

Description.—Length 30 mm, width 5 mm; both sexes strongly convex, the female much more so.

Head with a deep furrow on the vertex extending downward to between the antennae; labrum and clypeus each with a fringe of close spaced setae, those of the clypeus much the longest; side of head above the clypeal fringe with 6 to 8 widely separated setae, a pair between the antennae and a more widely spaced pair on the vertex; antennae slender, not as long as width of the body and with joints 2–6 inclusive subequal in width and length.

First segment with a rather thick, raised margin extending from just below the antennae to the lateral angle on each side.

Lateral carinae of male projecting outward nearly twice as far as those of female; margins of carinae thickened, posterior angles rounded-obtuse and not produced backward except very slightly on segments 17 and 18, the carinae of segment 19 greatly reduced in size, thin, and with the posterior corner on each side small, acute and definitely produced behind the median margin. Pores opening outward from the customary segments.

Gonopods (Fig. 18) with the posterior divi-

sions very long and slender, crossing each other and passing up the sides of the body, between legs 5 and 6, half way to the lateral carinae; outer portion of each division composed of two slender subequal closely applied pieces; anterior division of gonopods small, conical and not projecting beyond the opening in the segment; the margin of the opening through which the gonopods project thinly raised, highest on the sides.

Coxae of third male legs each with a rounded, hispid lobe on the ventral face.

Motyxia expansa, n. sp.

One male (type) and two females collected at "The Grapevine" below Fort Tejon, Calif., February 28, 1929, by O. F. Cook. U.S.N.M. no. 2093.

Diagnosis.—Differing from Chamberlin's *tejona* and *monica* in minor details of the gonopods, and from the latter, at least, in the more restricted carinae of segments 18 and 19.

Description.—Male 25 mm long and 4.5 mm wide, the largest female 27 mm long and 5 mm wide; male almost as convex as females.

Living color in general light salmon which is most intense on the lateral carinae and along the posterior half of the segments; head, antennae, legs and ventral surface uncolored.

Segments 2, 3 and 4 of typical shape but segments 17, 18 and 19 with lateral carinae much less produced than those of *monica*, segment 19 being almost completely hidden within 18 and its posterior angles small, inconspicuous and very widely separated.

Gonopods as shown in Fig. 19, rising from a transversely oval opening having a thick raised rim behind.

Third male legs each with a rounded coxal lobe, higher than broad, at the inner angle; sternum between fourth legs with a pair of broad, low, rounded elevations.

Remarks.—It is obvious that *expansa*, *tejona* and *monica* are very closely related, but if details of the authors' drawings of the gonopods of these species are compared, it will be seen that specific differences exist. Following the description of *tejona* (Proc. Acad. Nat. Sci. Phila., **99:** 25, 1947) Chamberlin listed the other species in the genus but overlooked *monica*. Having done so, it is probable that he did not compare *tejona* with its closest known relative, but he did compare it with the more distantly related *kerna*.

Motyxia exilis, n. sp.

Several males, one the type, and several females collected at Woodford, near Tehachapi, Calif., January 8, 1928, by O. F. Cook. U.S.N.M. no. 2094.

Diagnosis.—The three slender terminal divisions of the gonopods immediately distinguish this species.

Description.—Somewhat more sturdy than *expansa*, a small male being 25 mm long and 5.5 mm wide and the largest specimen, a female, 30 mm long and 7 mm wide, the males obviously less convex than females.

Living color not noted but the alcoholic specimens are light in shade.

Segments 2, 3 and 4 of customary shape. Segments 17, 18 and 19 with posterior angles backwardly produced; those of segment 18 most prominent; those of segment 19 very small and widely separated; posterior angles of these three segments more acute in males than females and moreso than in either *monica* or *expansa*.

Gonopods as shown in Fig. 20. They protrude from an opening extending backward at middle between the coxae of the eighth legs and with the margining rim higher and thinner than in *expansa*, the coxae less widely separated than in that species.

Males with coxae of third legs each with a smaller lower lobe than in *expansa*; sternum between the fourth legs with the two transverse elevations more pronounced than in *expansa*.

HERPETOLOGY.—*A new snake of the genus* Oligodon *from Annam.* ALAN E. LEVITON, Natural History Museum, Stanford University, Calif. (Communicated by Doris M. Cochran.)

Recently Dr. Doris Cochran, of the United States National Museum, submitted the entire collection of the genus *Oligodon* in the Museum to me for study. She called my attention to one specimen from Indo-China that she was unable to identify and presumed to represent a new species. Subsequent study has led to the confirmation of Dr. Cochran's suspicions.

Oligodon annamensis, n. sp.

Holotype.—U.S.N.M. no. 90408, young female, from Blao, Haut Donai, Annam, French Indo-China; collected by E. Poilane, March 11, 1933.

Diagnosis.—The new species of *Oligodon* differs from all previously described forms by a combination of the following characteristics: Maxillary teeth 8, anal shield single, scales in 13 rows, loreal absent, 6 upper labials, 1 postocular, internasals present.

Description.—Rostral well developed, as broad as deep, the portion visible from above less than half its distance to the frontal. Internasals broader than wide, not separated by the rostral; profrontals larger than the internasals, about one and one-third times as broad as wide, in contact with the second upper labial, nasal, and preocular shields; frontal one and one-third times longer than its distance to the snout, somewhat longer than broad, two times as wide as the supraocular, slightly shorter than the parietals; nasal large, partially divided; loreal absent; one preocular and one postocular; temporals 1 + 2. There are six upper labials, the third and fourth enter the eye; the order in decreasing size is 5, 6, 4, 3, 2, 1. Six lower labials, the first four in contact with the anterior genials which are about two times as long as the posterior shields.

Ventrals 170; subcaudals 30; anal single; scales in 13-13-13 rows.

Maxillary teeth 8, the extreme anterior portion of the maxillary bone edentulous. Three well developed palatine teeth present; no pterygoid teeth were observed.

Eye moderate, its diameter equal to twice its distance to the lip; pupil round.

Measurements.—Total length, 249 mm; tail length, 29 mm.

Coloration.—(Specimen preserved in 75 per cent alcohol.) Ground color light brown. On the head there are several areas of white, black-edged blotches; these include an interocular band, a short interparietal bar, and some small areas on the anterior portion of the snout. The rostral is white, strongly spotted by dark flecks as are the white areas of the bars on the head. A white blotch just in front of the eye covers parts of the second and third upper labials; another blotch extends from the fifth and sixth upper labials diagonally forward to the top of the head where it meets with the interocular band just above the eye. Both of these lateral white areas extend onto the lower labials and genials. There is a long oblique stripe on the neck which extends forward and onto the posterior edge of the parietal; this stripe does not meet its fellow on the parietals. The body is transversed by a series of white black-edged bars, some of which are indistinct; this pattern extends onto the tail. Most of the body scales are edged by darker brown and are all peppered by fine dark flecks.

Ventrally the ground color is white; many of the ventrals and subcaudals are either partially or completely covered by dark brown or black quadrangular spots.

Remarks: There are but three species in the genus *Oligodon* with which *annamensis* could be confused, i.e., *ornatus*, *catenata*, and *violaceus pallidocinctus* (= *cinereus*, var. IV of Smith, 1943). It can be distinguished from these three forms as follows: *ornatus–annamensis* has an undivided anal plate and 13 scale rows while *ornatus* has a divided plate and 15 scale rows; *catenata-annamensis* has a single anal plate and a distinct pair of internasal shields while *catenata* has a divided anal plate and lacks internasals; *cinereus*,

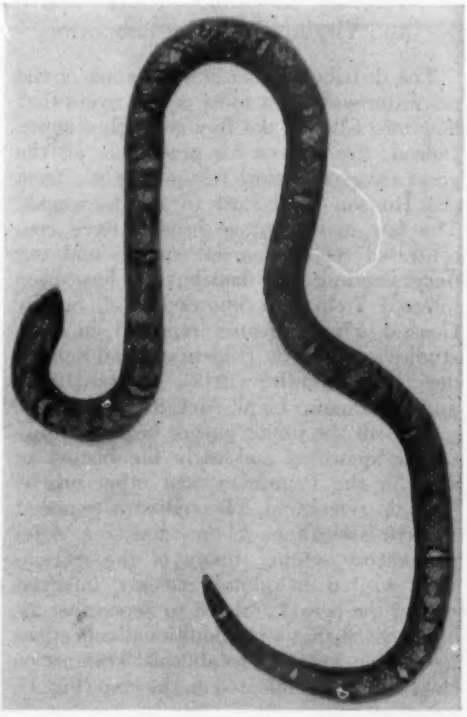


FIG. 1.—Holotype of *Oligodon annamensis*, U.S.N.M. no. 90408.
(Photograph by Antenor L. Carvalho)

var. IV—*annamensis* lacks the loreal and has 13 scale rows while *cinereus* has a loreal shield and either 15 or 17 scale rows.

There can be little doubt that *annamensis* represents a "degenerate" species. This is exemplified by the reduction in the number of head shields, i.e., loss of the loreal, fewer upper labials, and low number of scale rows. Since the tendency toward the reduction in numbers of scales is to be found among many species that represent several species groups within the genus *Oligodon*, great care must be exercised in the interpretation of these traits, and any conclusions concerning relationships derived from such data must be accepted on a provisional basis. A thorough study of the structure of the hemipenes, a problem that I am at present working on, seems to offer the only means by which the seemingly complex evolutionary history of the genus will be unscrambled.

Because of the lack of data concerning the structure of the hemipenes to be found in *annamensis*, any statement of relationships must be for the present considered purely speculative. However, from the evidence available it seems most likely that *annamensis* was derived from *cinereus*. The validity of this supposition must be determined in the future when and if additional specimens of this species, particularly males, may be available for examination.

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ICHTHYOLOGY.—*The fishes of the tidewater section of the Pamunkey River, Virginia.* EDWARD C. RANEY and WILLIAM H. MASSMANN, Cornell University and Virginia Fisheries Laboratory.[1]

The distribution of the fish fauna of the tidewater section of most of the rivers that flow into Chesapeake Bay is poorly known. Indeed, this is true for practically all the great rivers tributary to the Atlantic from the Hudson southward to the Savannah. The few investigations usually have concentrated on commercial species and our understanding of distribution has been inferred from the knowledge of nearby Coastal Plain streams reported in such studies as those by Hildebrand and Schroeder (1928), Fowler (1945), Raney (1950), and Massmann, Ladd, McCutcheon (1952).

In 1949 the junior author began a study of the spawning and early life history of shad in the Pamunkey and other nearby Virginia rivers and collected with seines at numerous locations in the tidal area. After exploratory seining, many of the stations were visited at almost weekly intervals during the period June 28 to September 29, 1949. Since that time additional collections have been made at established stations on the Pamunkey indicated on the map (Fig. 1).

[1] Contribution from the Virginia Fisheries Laboratory.

A minnow seine, 20 feet long and 4 feet in depth, was used in all but six collections when a net 75 by 6 feet was employed. All seines had a bar mesh size of ¼ inch. The collections included 113 samples taken by minnow seine, 15 by surface trawl, 6 by rotenone, 4 by bottom trawl, and a series of plankton net collections which often contained small fishes. Continuous observations were made on the commercial and sport fisheries. Many of the collections were sent to the senior author, who is responsible for the identification of all but the clupeid fishes. A total of 59 species were taken in the Coastal Plain region of the Pamunkey River and its tributaries; 52 were limited to the tidewater section.

DESCRIPTION OF THE LOWER PAMUNKEY RIVER

The Pamunkey River (Fig. 1) originates on the Piedmont plateau at the confluence of the North and South Anna Rivers, 5 miles northeast of Ashland, Va., and empties into the York River at West Point. The tidal region extends about 42 nautical miles upstream to the vicinity of Bassett Bar. At West Point, salinities ranging from 0 to

12.6 parts per thousand have been recorded; the river generally becomes fresh between West Point and Romancoke at a point 8 miles upstream. The precise boundary between fresh and brackish water varies with river runoff, wind, and tide, as does the head of the tide itself. The tidal range averages about 3 feet. Turbidities, as measured with a Secchi disk, range from 27 to 61 cm; the upper sections of the river are generally clearer than the lower reaches. Submergent vegetation, of which the predominant form is *Nitella*, although sparse in the river, is found in abundance in a few protected coves.

The tidal portion of the river may be divided into three rather homogeneous physiographic areas each approximately 15 miles in length. Area I (Fig. 1) is characterized by a wide channel which is from 20 to 60 feet deep and rather steep mud banks. It is surrounded by extensive tidal marshes. Eight small gravel and/or sand beaches are present in this section. Area II is centered near Lester Manor. Here the river generally is wider, and is fed by many marsh creeks. Shoal areas, less than 5 feet in depth, are extensive, and numerous coves are present. The shoreline is mostly wooded. About a dozen sand and/or gravel beaches suitable for seining are present. Area III has an average depth of 12 feet, and few shoal areas, which are located in the mouths of tributary creeks. The muddy banks are rather steep and only about six small sand and/or gravel beaches are suited to seining. The shoreline is generally forested.

FISHERIES OF THE PAMUNKEY RIVER

The American shad and catfishes (*Ictalurus*) are the major species of commercial importance on the Pamunkey River. Shad are caught during the spawning run in spring, mainly with drift gill nets, although a few set or stake gill nets are fished at West Point. In depth the drift nets may be

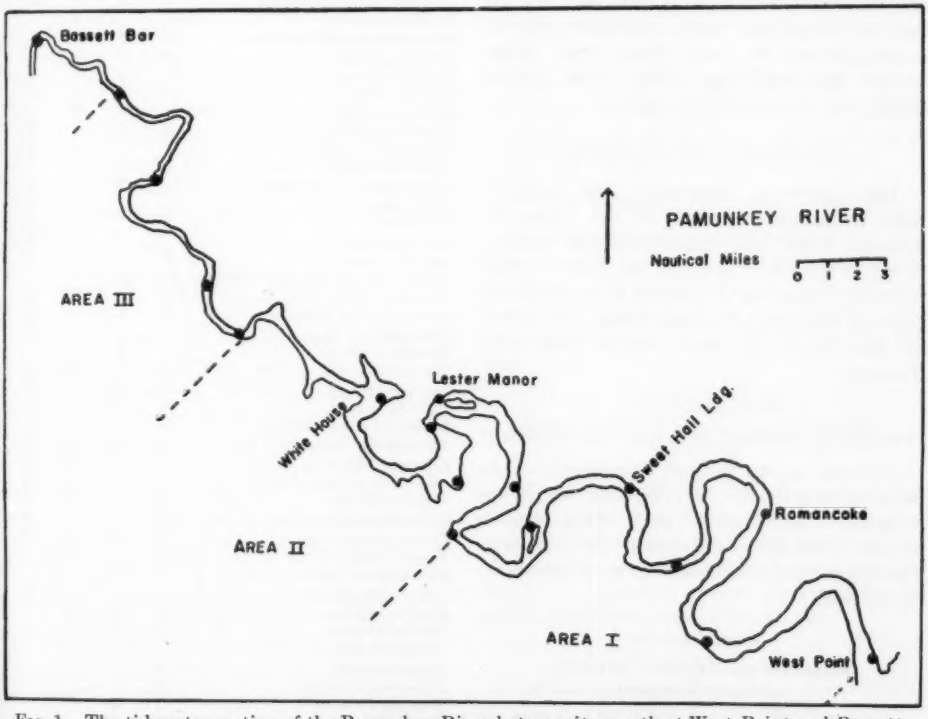

FIG. 1.—The tidewater section of the Pamunkey River between its mouth at West Point and Bassett Bar a point approximately 42 nautical miles upstream, showing localities mentioned in text

as much as 25 feet, depending on the water depths being fished; in length they vary from one-quarter to one-half the width of the channel. In area I, striped bass are often taken in shad nets. The alewife, glut herring, and hickory shad are also captured but generally, because of their smaller size, these fishes escape through the meshes of shad nets. A few small hoop fyke nets are fished in area I and their catch includes white perch, glut herring, alewife, and catfishes. In the vicinity of Lester Manor, a single haul seine operates and takes white perch, carp, striped bass, gizzard shad, and redhorse sucker. Catfishes are generally taken in catfish pots although two fishermen still use the more primitive trot lines. With the exception of catfish pots, White House is the upper limit of commercial fishing on the Pamunkey, since the river beyond that point is not suited to the use of commercial nets.

To obtain small quantities of fish for local consumption herring drift nets and set gill nets are sometimes used. Extensive angling is not carried on, but striped bass, largemouth bass, catfishes, white perch, yellow perch and sunfishes are taken.

ANNOTATED LIST OF FISHES

The following annotated list includes only those fishes taken in the tidewater section. Their distribution in the several areas of the river is given in Table 1. The number appearing at the end of each species account represents the percentage frequency of occurrence in seine hauls. (See also Table 2.)

PETROMYZONTIDAE

Petromyzon marinus Linnaeus: Sea Lamprey

Although no sea lamprey was caught or observed during the survey, it has been seen in the adjacent Chickahominy and Rappahannock Rivers. Local fishermen reported its capture in past years when nets of smaller mesh were commonly used.

ACIPENSERIDAE

Acipenser oxyrhynchus (Mitchill): Atlantic Sturgeon

A small specimen was taken in a shad drift net at Lester Manor. Formerly common, it is now seldom seen.

TABLE 1.—Phylogenetically arranged list of the Coastal Plain fishes of the Pamunkey River system. Areas I, II, and III are from the tidewater section of the lower Pamunkey River as shown in Fig. 1. Area IV represents collections from tributaries to the tidewater section and the upstream Pamunkey River from Bassett Bar to the Fall Line. Species marked by an asterisk were also collected in the Piedmont region of the Pamunkey River system. Type of record: X—collected, O—observed, R—reliably reported by fishermen.

Species	Area			
	I	II	III	IV
Petromyzon marinus		R		
Acipenser oxyrhynchus		O		
Lepisosteus o. osseus	X	X		
Amia calva		X	X	
Alosa mediocris	X	X		
Alosa aestivalis	X	X	X	
Alosa pseudoharengus	X	X	X	
Alosa sapidissima	X	X	X	
Brevoortia tyrannus	X	X		
Dorosoma cepedianum	X	X		
Anchoa m. mitchilli	X	X		
*Erimyzon o. oblongus**				X
*Mozostoma macrolepidotum**	X	X	X	
Cyprinus carpio		O		
*Semotilus corporalis**	X		X	X
*Semotilus a. atromaculatus**				X
*Hybopsis leptocephalus**				X
Notemigonus c. crysoleucas	X	X	X	X
Notropis amoenus			X	
Notropis hudsonius saludanus	X	X	X	X
*Notropis analostanus**	X	X	X	X
Hybognathus nuchalis regius	X	X	X	X
Ictalurus catus	X	X	X	X
Ictalurus p. punctatus	X	X	X	
Ameiurus natalis erebennus	X	X		X
*Ameiurus n. nebulosus**	X			X
Schilbeodes mollis	X	X	X	
*Schilbeodes m. marginatus**		X		X
Umbra pygmaea				X
*Esox niger**	X		X	X
*Esox americanus**			X	X
*Anguilla rostrata**	X	X	X	X
Fundulus heteroclitus macrolepidotus	X	X	X	
Fundulus d. diaphanus	X	X	X	X
Gambusia affinis holbrooki	X	X	X	X
*Aphredoderus s. sayanus**				X
Strongylura marina		X	X	
Roccus saxatilis	X	X	X	X
Morone americana	X	X	X	X
Perca flavescens	X	X	X	X
Etheostoma nigrum olmstedi	X	X	X	X
Micropterus s. salmoides	X	X	X	X
*Lepomis gibbosus**	X	X	X	X
*Lepomis m. macrochirus**	X	X	X	X
*Lepomis auritus**	X	X	X	X
Centrarchus macropterus				X
Pomoxis nigromaculatus	X	X	X	X
Enneacanthus gloriosus	X	X	X	X
Enneacanthus obesus	X			
*Acantharcus pomotis**				X
Menidia beryllina	X	X	X	
Menidia menidia	X	X		
Peprilus alepidotus	X			
Cynoscion regalis	X			
Leiostomus xanthurus	X			
Micropogon undulatus	X	X		
Gobiosoma bosci	X			
Paralichthys dentatus	X			
Trinectes maculatus	X	X	X	

LEPISOSTEIDAE

Lepisosteus osseus osseus (Linnaeus): Eastern Longnose Gar

Numerous in areas I and II. On one boat trip large numbers of adults were observed near the surface between West Point and White House. One shad fishing reach near Lester Manor is seldom used because the gar, which damage shad nets, is so abundant in the area. Only three young gar were taken by minnow seine. 4.

AMIIDAE

Amia calva Linnaeus: Bowfin

Several were observed on the beach at the Pamunkey Indian Reservation where they had been discarded from gill net catches, and two were collected near Bassett Bar. Fishermen reported an increase in abundance in recent years.

CLUPEIDAE

Alosa mediocris (Mitchill): Hickory Shad

It migrates into the Pamunkey in spring to spawn and females in various stages of ripeness, and spent specimens were frequently seen although Hildebrand and Schroeder (1928, p. 84) reported to the contrary. This species was observed in commercial catches from West Point to White House. Although only three juveniles were collected while seining, 91 young were taken in two 15-minute hauls with a surface trawl in area I. 2.

Alosa aestivalis (Mitchill): Glut Herring

The most abundant of the river herrings. It generally spawns in tidal waters, but sometimes also in the tributaries. The main spawning migration follows that of the American shad, and usually occupies about three weeks. During this short but heavy run, canneries are often supplied with more herring than they can utilize, hence the common name, glut herring. However, this herring generally is not taken commercially on the Pamunkey since almost the entire fishing effort is directed toward the more valuable American shad. Juveniles are present in large numbers during the summer months and probably constitute one of the most important forage fishes. Young glut herring were collected at most stations from brackish waters to the head of tidewater. 35.

Alosa pseudoharengus (Wilson): Alewife

The main spawning run generally precedes that of the American shad by several weeks. Spawning often takes place in tributaries, but also in tidal waters. Young have been taken from all sections of the river. 17.

Alosa sapidissima (Wilson): American Shad

The main spawning run arrives in April although a few adult shad have been observed in the commercial catch from November to July. Spawning takes place in the freshwater tidal section of the river but is most concentrated in area II, as reported by Massmann (1952). Young shad were taken at most stations in fresh tidal waters. Greater numbers of young shad have been collected in the Pamunkey than in the Mattaponi or Rappahannock rivers. 57.

Brevoortia tyrannus (Latrobe): Menhaden

Although the menhaden is primarily a marine species, young are often found in fresh water. From area I, postlarval menhaden 20 to 30 mm. in length were collected in plankton nets during April, 1950. In the summer young menhaden were seined at stations in areas I and II. Collections from the Rappahannock River indicate that large numbers of young may be found in fresh-water during the summer months. 5.

Dorosoma cepedianum (LeSueur): Gizzard Shad

Observed at Lester Manor, where a few were taken in shad nets. Juveniles were collected in the mouth of a tidal creek, one mile south of Sweet Hall Landing. Fishermen reported that this species has become scarce in the past ten years.

ENGRAULIDIDAE

Anchoa mitchilli mitchilli (Valenciennes): Anchovy

Although typically marine, all stages of this anchovy from post-larvae to adult, may be present in large numbers in the rivers. The occurrence of postlarval specimens in fresh water suggests that it may spawn in or near the Pamunkey. It was collected from areas I and II. 16.

CATOSTOMIDAE

Moxostoma macrolepidotum (LeSueur): Eastern Redhorse Sucker

This is the common sucker of the region. It

was found in all parts of the river. Young and juveniles were taken in seines, and adults were noted in summer gill net catches. 20.

CYPRINIDAE

Cyprinus carpio (Linnaeus): Carp

Occasionally taken in the haul seine operated from Lester Manor. Not common in the Pamunkey but the carp is fished commercially in both the Chickahominy and James rivers.

Semotilus corporalis (Mitchill): Fallfish

Two juveniles were taken from area I and fourteen adults were caught in one-half hour of angling at Bassett Bar. However, the favorite habitat of this form is upstream from the Fall Line. 2.

Notemigonus crysoleucas crysoleucas (Mitchill): Eastern Golden Shiner

A sluggish water form which was taken more frequently in coves than from the river channel. Collected at many locations between brackish water and the head of tidewater. 6.

Notropis amoenus (Abbott): Attractive Shiner

A single juvenile was taken in area III. Typically found upstream in pools usually near moving water. 1.

Notropis hudsonius saludanus (Jordan and Brayton): Southern Spottail Shiner

This gregarious shiner, one of the most common fishes in the shore zone, was taken in all sections of the river. It is probably an important forage fish. 63.

Notropis analostanus (Girard): Satinfin Shiner

This shiner was slightly more abundant than the spottail shiner in collections made during 1949, 1950, and 1951. In 1952 the spottail shiner appeared in approximately the same abundance as in previous years, but the satinfin shiner was scarce. It is an excellent bait minnow. 60.

Hybognathus nuchalis regius (Girard): Eastern Silvery Minnow

This common minnow, taken from all three river areas was generally more abundant in the river proper than in coves. 20

AMEIURIDAE

Ictalurus catus Linnaeus: White Catfish

An important commercial species and common in most of the river. It was seined about as frequently as the channel catfish. Fishermen reported that the white catfish will not enter catfish pots as readily as the channel catfish, and often used underwater fyke nets in areas where the former is more abundant. 12.

Ictalurus punctatus punctatus (Rafinesque): Channel Catfish

This introduced species is of about equal importance commercially as the native white catfish. The catfish fishery on the Chickahominy River was described by Menzel (1943). 10.

Ameiurus natalis erebennus Jordan: Southern Yellow Bullhead

Adults and young, taken in only three collections, were found in areas I and II. This species is common in the Chickahominy River.

Ameiurus nebulosus nebulosus (LeSueur): Northern Brown Bullhead

Collected only once in the Pamunkey at Sweet Hall Landing. It is common in some of the ponds near the tidewater section and was taken frequently in collections from the Rappahannock River. Fishermen reported that it occasionally was taken on the mud flats by set gill nets.

Schilbeodes mollis (Hermann): Tadpole Madtom

Adults and young were taken from all three areas and it was more abundant it coves than in the river proper. 6.

Schilbeodes marginatus marginatus (Baird): Common Eastern Madtom

One adult was taken in a plankton net at Lester Manor. The species is typically found in riffles at or above the Fall Line where it is fairly common. It is probably to be considered a straggler in the lower river.

ESOCIDAE

Esox niger (LeSueur): Chain Pickerel

Adults were taken from a cove at Sweet Hall Landing and a creek mouth at Bassett Bar. This species seems to avoid tidal waters where local fishermen also reported it as rare. It is fairly

common in the tributaries and upstream from the Fall Line.

Esox americanus Gmelin: Bulldog Pickerel

Like the chain pickerel this species is seldom seen in the tidal section of the river. Several were collected at the mouth of a tidal creek near Bassett Bar.

ANGUILLIDAE

Anguilla rostrata (Le Sueur): American Eel

This eel was collected at almost every locality on the Pamunkey River. Many elvers were taken in plankton nets during the spring. 17.

CYPRINODONTIDAE

Fundulus heteroclitus macrolepidotus (Walbaum): Mummichog

A more typically marine killifish which was taken most frequently near saltwater, but was found throughout the tidewater section. 7.

Fundulus diaphanus diaphanus (Le Sueur): Eastern Banded Killifish

Slightly more than one-half of the seine collections contained this killifish. It was common in hauls from stations near brackish water to the head of the tide. 55.

POECILIIDAE

Gambusia affinis holbrooki (Girard): Eastern Mosquitofish

A typical quiet water Coastal Plain form which more frequently appeared in hauls made in coves and backwaters. It was taken in each of the three river areas. 18.

BELONIDAE

Strongylura marina (Walbaum): Atlantic Needlefish

This marine species was collected only in areas II and III, but undoubtedly occasionally occurred in area I. One specimen 23 mm. in length was taken by dip net at Lester Manor in April. This species and other members of the Belonidae are well known for their habit of entering freshwaters and are sometimes found far from the sea. 2.

SERRANIDAE

Roccus saxatilis (Walbaum): Striped Bass

Young were taken in seine collections from all three river areas. Tresselt (1952) found striped bass eggs only in area I. Adults, often taken in the spring by shad fishermen, occur most frequently downriver from Lester Manor. However, anglers have taken striped bass in June ten miles above Bassett Bar. The species appears to be more abundant in both the Mattaponi and Rappahannock rivers than in the Pamunkey. 35.

Morone americana (Gmelin): White Perch

A common and widely distributed species collected in more than half of the seine hauls between brackish water and the head of the tide. Although frequently seined it does not appear to be as abundant in the Pamunkey as in the James or Rappannock rivers. In the past it was taken in set gill nets fished near Lester Manor in January or February but this fishery has been discontinued. Most of the white perch now taken are captured in hoop fyke nets located in area I. 54.

PERCIDAE

Perca flavescens (Mitchill): Yellow Perch

Collected mostly in coves and creek mouths from all three river areas. 12.

Etheostoma nigrum olmstedi (Storer): Tessellated Johnny Darter

Common and widespread, this species was taken in more than one-half the seine collections in all areas of the river. 53.

CENTRARCHIDAE

Micropterus salmoides salmoides (Lacépède): Northern Largemouth Bass

Taken in collections from all three areas, but appears to prefer creeks and coves to the river proper. 7.

Lepomis gibbosus (Linnaeus): Pumpkinseed Sunfish

Captured in samples from all areas and was taken about one-half as often as the bluegill. 16.

Lepomis macrochirus macrochirus Rafinesque: Common Bluegill

A widespread and common species which apparently exceeds the other sunfishes in abundance. 36.

Lepomis auritus (Linnaeus): Yellowbelly Sunfish

Found throughout the river. It appears to be

more typically a river fish than are the other centrarchids, for it was more abundant in collections from the main stream than in coves. However, it also is widespread in its upstream distribution and is often common in small tributaries. 22.

Pomoxis nigromaculatus (LeSueur): Black Crappie

Occurred in scattered collections from all three river areas. 10.

Enneacanthus gloriosus (Holbrook): Bluespot Sunfish

Taken in collections from brackish waters to the head of the tide. It was more abundant in coves than in the river proper. 11.

Enneacanthus obesus (Girard): Banded Sunfish

Taken only once in the mouth of a creek at Sweet Hall Landing.

ATHERINIDAE

Menidia beryllina (Cope): Glassy Silverside

Collections from all areas of the river included this species and it appears to be more abundant in the tidal freshwaters than in salt water. Although abundant in collections from the river course, it was seldom taken in coves. 24.

Menidia menidia (Linnaeus): Atlantic Silverside

Occurred in areas I and II and is common in Chesapeake Bay. This species occasionally is found in freshwater. 6.

STROMATEIDAE

Peprilus alepidotus (Linnaeus): Harvestfish

Several were taken by surface trawl 5 miles upriver from West Point. When collected at high tide the surface salinity was 8.9 parts per thousand but on the succeeding low tide the water at that location became fresh. Harvest fish have been collected from waters of even lower salinity in the Mattaponi River but have not yet been found by us in water that was completely fresh.

SCIAENIDAE

Cynoscion regalis (Bloch and Schneider): Gray Squeteague

Young were taken by surface trawl in the freshwaters of area I. This species is generally found in salt water, but was recorded from freshwater by Gunter (1942).

Leiostomus xanthurus Lacépède: Spot

Young spot 20 to 40 mm. in length were taken in plankton nets while juveniles were collected by seine and surface trawl in area I. Spot was taken in both fresh and brackish waters. In the Rappahannock River it was collected 23 miles above brackish water and young have also been taken in the freshwaters of Mattaponi River. 3.

Micropogon undulatus Linnaeus: Atlantic Croaker

Young 20 to 30 mm. in length were collected in plankton nets in area I and small specimens were taken in plankton nets set at Lester Manor (area II) in March, 1949. Both croaker and spot have been recorded previously from freshwater by Gunter (1942). Their occurrence in freshwater at such a small size is unusual, for both species are believed to spawn in the ocean outside of Chesapeake Bay. Young of both species have also been taken in plankton nets in freshwaters of the Mattaponi River.

GOBIIDAE

Gobiosoma bosci Lacépède: Naked Goby

Several specimens were collected in one seine haul five miles above West Point. This species is commonly taken near oyster beds which are not found in the Pamunkey River. 1.

HIPPOGLOSSIDAE

Paralichthys dentatus (Linnaeus): Summer Flounder.

A single specimen of this typically salt-water species was seined 5 miles above West Point. It is commonly caught commercially in the York River below West Point. 1.

ACHIRIDAE

Trinectes maculatus (Bloch and Schneider): Hogchoker

Young were especially common in the tidal freshwaters. It was taken in many samples from the mouth of the Pamunkey River to the head of the tide. 28.

FISHES OF ADJACENT SECTIONS

Scattered collections were made in small streams tributary to the tidewater section and from the Coastal Plain area of the Pamunkey upstream from the limit of Bassett Bar (area III). The tributary streams were typically clear and shallow with sand

bottom and slight gradient, and all flow through wooded areas. Two of the best stations were located in pools just below mill dams. The stations in the Pamunkey River above area III were deep with steep banks which made seining difficult. Fishes taken in the above situations were *Erimyzon oblongus oblongus* (Mitchill), eastern creek chubsucker; *Semotilus atromaculatus atromaculatus* (Mitchill), northern creek chub; *Hybopsis leptocephalus* (Girard), Carolina chub; *Umbra pygmaea*, eastern mudminnow; *Aphredoderus sayanus sayanus* (Gilliams), eastern pirateperch; *Centrarchus macropterus* (Lacépedè), flier; and *Acantharcus pomotis* (Baird), mud sunfish.

In five collections made in Pamunkey River and tributaries above the Fall Line in Louisa and Hanover counties, 12 additional forms not listed in Table 1 were captured. They are as follows: *Catostomus c. commersoni* (Lacépède), *Hypentelium nigricans* (LeSueur), *Hybopsis micropogon* (Cope), *Exoglossum maxillingua* (LeSueur), *Chrosomus oreas* Cope, *Clinostomus vandoisulus* (Valenciennes), *Notropis cornutus cornutus* (Mitchill), *Notropis procne procne* (Cope), *Hadropterus notogrammus* Raney and Hubbs, *Hadropterus peltatus peltatus* (Stauffer), *Etheostoma nigrum* Rafinesque subsp., *Etheostoma vitrea* (Cope). These limited data on Piedmont fish distribution indicate that in this respect the Pamunkey River is much like the James River, as reported by Raney (1950, p. 189).

RELATIVE ABUNDANCE

The abundance of fishes is sometimes measured by their frequency of occurrence in collections made by seine hauls. This method has some limitations especially in large rivers. Recent investigations on the clupeid fishes reported by Massmann, Ladd, and McCutcheon (1952) has indicated that seining is not always a reliable measure of abundance. Other groups, such as the catfishes, are primarily nocturnal, and therefore estimations of abundance based on daytime seine hauls may be erroneous. Fishes such as the hogchoker and eel often burrow in the mud where they are easily missed by minnow seines. The young of several species, such as longnose gar, bowfin and carp rarely

TABLE 2.—Fishes taken in the tidewater section of the Pamunkey River arranged in order by frequency of occurrence in percentage of seine hauls. Some species are included here with full realization that seine collections do not reveal their true relative abundance.

Species	Frequency of occurrence in percent	Species	Frequency of occurrence in percent
Notropis hudsonius saludanus	63	*Anchoa m. mitchilli*	16
Notropis analostanus	60	*Lepomis gibbosus*	16
Alosa sapidissima	57	*Ictalurus catus*	12
Fundulus d. diaphanus	55	*Perca flavescens*	12
Morone americana	54	*Enneacanthus gloriosus*	11
Etheostoma nigrum olmstedi	53	*Ictalurus punctatus*	10
Lepomis m. macrochirus	36	*Pomoxis nigromaculatus*	10
Alosa aestivalis	35	*Fundulus heteroclitus macrolepidotus*	7
Roccus saxatilis	35	*Micropterus s. salmoides*	7
Trinectes maculatus	28	*Menidia menidia*	6
Menidia beryllina	24	*Notemigonus c. crysoleucas*	6
Lepomis auritus	22	*Schilbeodes mollis*	6
Moxostoma macrolepidotum	20	*Breevoortia tyrannus*	5
Hybognathus nuchalis regius	20	*Lepisosteus o. osseus*	4
Gambusia affinis holbrooki	18	*Leiostomus xanthurus*	3
Anguilla rostrata	17	*Strongylura marina*	2
Alosa pseudoharengus	17	*Semotilus corporalis*	2
		Alosa mediocris	2
		Notropis amoenus	1
		Gobiosoma bosci	1
		Paralichthys dentatus	1

TABLE 3.—Relative abundance of the most common Pamunkey fishes seined in coves and in the river proper. The numbers are the ratios between the percentages of occurrence in seine hauls at the two habitats.

Species	River proper	Coves
Menidia beryllina	4.7	1.0
Hybognathus nuchalis regius	3.7	1.0
Trinectes maculatus	3.3	1.0
Lepomis auritus	3.0	1.0
Roccus saxatilis	2.0	1.0
Moxostoma macrolepidotum	1.6	1.0
Anchoa m. mitchilli	1.5	1.0
Notropis hudsonius saludanus	1.4	1.0
Fundulus heteroclitus macrolepidotus	1.3	1.0
Etheostoma nigrum olmstedi	1.1	1.0
Alosa aestivalis	1.0	1.1
Notropis analostanus	1.0	1.1
Ictalurus catus	1.0	1.1
Morone americana	1.0	1.1
Pomoxis nigromaculatus	1.0	1.1
Anguilla rostrata	1.0	1.2
Alosa sapidissima	1.0	1.4
Fundulus d. diaphanus	1.0	1.4
Gambusia affinis holbrooki	1.0	1.6
Micropterus s. salmoides	1.0	1.7
Enneacanthus gloriosus	1.0	2.5
Perca flavescens	1.0	2.9
Lepomis gibbosus	1.0	3.7
Lepomis m. macrochirus	1.0	4.0
Schilbeodes mollis	1.0	5.0
Alosa pseudoharengus	1.0	5.5
Notemigonus c. crysoleucas	1.0	13.0

are taken in minnow seines, in Virginia rivers, even though adults may be numerous. Densely schooling fishes such as the glut herring and menhaden may be far more abundant than their percentage of occurrence in seine hauls would indicate merely because these schools may be met infrequently while fishes of more uniform distribution would ordinarily be taken more often. Anadromous species, which make up a considerable part of the fish fauna in tidal rivers, may be present for only part of the year in any given ontogenetic stage, and sampling therefore is representative only of the season when collecting occurred.

The percentage of seine collections in which the various species occurred is given in Table 2. The spottail shiner was taken most frequently followed by satinfin shiner, American shad, banded killifish, white perch, and johnny darter, all of which appeared in more than one-half of the seine hauls. Next in order of frequency of capture are the bluegill sunfish, glut herring, striped bass, hogchoker, glassy silverside and yellowbelly sunfish. The remaining fishes occurred in 20 per cent or fewer seine hauls.

Distribution

The habitat in which sampling is done is of considerable importance in determining the species that are taken. Even in a tidal river, where the various habitats tend to be unified by the influence of a mass of water of rather uniform physical and chemical characteristics (excluding the brackish waters), there are some differences in the environmental preferences of fishes.

A distinct contrast is evident between coves, where the water is not affected by tidal currents, and the river proper where the effect of such currents is pronounced. The occurrence of fishes at cove and river stations is summarized in Table 3. Glassy silverside, silvery minnow, hogchoker, yellowbelly sunfish, and striped bass were collected more frequently in the river while golden shiner, alewife, tadpole madtom, bluegill sunfish, pumpkinseed sunfish, yellow perch and bluespot sunfish occurred more often in coves. The other species were intermediate. With the exception of the alewife, those fishes favoring the cove habitat are generally found in sluggish water or ponds throughout their range, while those common to the river may or may not be found in still water in other parts of their range.

It seems evident that the species of fishes obtained by sampling rivers was determined in part by the type of habitat sampled. Therefore, care must be exercised in selecting various locations that are adequately representative of all conditions. This is a difficult problem in rivers where sampling locations, especially by seine, are limited by water depth and bottom type.

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